RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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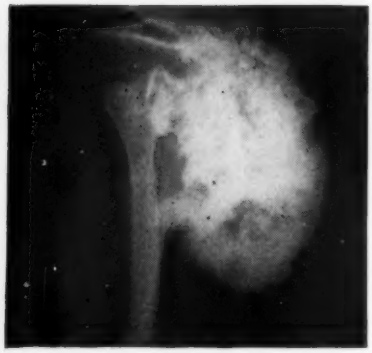

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Medulloblastoma: Non-Operative Management with Roentgen Therapy After Aspiration Biopsy[1]

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Montreal, Canada

INTRACRANIAL tumors arising during childhood fortunately are not overly frequent. But, too often, the symptoms and signs are not recognized for weeks to months, with the result that by the time the child is brought for definitive treatment, if he is not virtually moribund, his condition is grave. This is especially true with the medulloblastomas, whose common site of origin is in the cerebellum and roof of the fourth ventricle. Further, their history is commonly that of rapid tumor growth and ultimately marked tendency to disseminate throughout the subarachnoid spaces of the brain and spinal cord. Although of all the gliomas—indeed, of all intracranial primary neoplasms—medulloblastoma appears to be the most vulnerable to irradiation, the roentgen and neurosurgical literature is replete with reports of failures to control this tumor.

In the hope that some modification of the management of these cases might effect an improvement in this grim situation, the use of the twist-drill technic developed for ventriculography (W. V. C.) has been employed to afford means of obtaining biopsy tissue for histologic diagnosis in cerebellar tumors. This method has now been used in a total of 16 cases of suspected cerebellar tumors, with no complications. The results of this type of aspiration biopsy in these 16 cases have certainly proved it to be a necessary and useful procedure, since the tissues obtained showed the following variety:

Medulloblastomas	5
Medulloblastoma, proved to be so at operation	1
Astrocytomas	3
Glioblastomas	2
Abscess	1
Generalized encephalopathy	1
Three cases in which no abnormal tissue was obtained on biopsy but at operation proved to be:	
Medulloblastoma	1
Astrocytoma	1
Glioblastoma	1
	16

Thus, knowledgeable differentiation of the medulloblastomas from the astrocytomas and other conditions and decision as to initial surgical attack or intelligent administration of proper roentgen therapy are permitted, with a minimum of trauma, consequently minimal shock and minimal risk of dissemination of the neoplastic cells. This is in contrast to a policy of attempted surgical removal of the major part of the

[1] From the Departments of Neurosurgery and of Radiology, McGill University, Royal Victoria Hospital, and the Montreal Neurological Institute. Presented at the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Dec. 1–5, 1947. Submitted for publication in January 1949.

tumor followed by so-called "series" of roentgen therapy, sometimes repetitious and inadequate.

The results in our small group of unfortunate children have been encouraging so far.

GENERAL CONSIDERATIONS

The problem of management of cerebellar tumors is complex. The relatively slowly growing, localized, more commonly asymmetric astrocytomas, hemangiomas, and some ependymomas, without doubt, are best treated by radical operative intervention (Elvidge, Penfield, and Cone, 1937; Bailey, Buchanan, and Bucy, 1939).

The medulloblastomas present a different situation. The early vomiting is commonly mistaken as indicating a gastrointestinal disorder. The broad stance, widened gait, symmetrical involvement of the lower extremities without gross change in muscular control of the upper limbs, and the "nystagmus" are overlooked for weeks to months. Although there is a greater incidence of medulloblastoma under the age of ten years (Bailey), the less rapidly progressive, but almost as frequent, astrocytoma must be differentiated, if possible, before decision is taken as to the method of treatment. Medulloblastoma is further characterized by relatively rapid growth in usually less than fifteen months, and a rather marked "fertility," as manifest in the ability of some tumor cells to survive considerable irradiation and to propagate further tumors locally and elsewhere along the subarachnoid spaces, wherever they may settle down.

The operative mortality rate is high. Bailey, Buchanan, and Bucy (1939) report 22 per cent in 17 cases; Cushing (1930) 25.2 per cent in 68 cases; Elvidge, Penfield, and Cone 23.6 per cent in 17 cases.

Bailey and Cushing (1925) observed that *without postoperative irradiation*, the average survival was seven months; *with irradiation*, the average was nineteen months. Dyke's (1942) series showed some improvement, 22.3 months. In 11 cases which we have reported for the period 1939–44, the average survival following open operation and roentgen therapy was twenty-two months.

The histologic study of the effect of irradiation on the gliomas by Frazier, Alpers, Pendergrass, and Chamberlin (1937) confirmed the previous clinical observations on the advantage to be gained by irradiation of medulloblastomas. But, also, it emphasized the ability of some of the cells to survive the irradiation applied, and, in time, to resume propagation, with consequent recurrence as well as dissemination of the tumor. Their patients, as practically all others, were subjected to major surgical intervention. The program of roentgen therapy which they employed in the several cases cited demonstrates the groping for some pattern of irradiation which may prove to be less symptomatic and more permanent in the control of this malignant neoplasm. Their histologic data leave little doubt that if the neurosurgeon and the radiation therapist can devise a proper method, medulloblastoma may be controlled.

The type of operation has varied widely. Spitz, Shenkin, and Grant (1947) remove only enough of the tumor to open up the cerebrospinal-fluid pathways. Bailey *et al.*, after operative exposure, take a biopsy for diagnosis and then perform a wide decompression. Cushing advocated thorough local removal by dissection and suction, as did Penfield, Cone, and Elvidge in 1937. Frazier and his associates apparently varied their surgical measures, taking a biopsy only in some at the initial suboccipital decompression; secondarily, subtotal removal of the tumor was apparently essayed.

PRINCIPLES UNDERLYING NEW APPROACH

On the thesis that these children would do as well, and perhaps better, if the trauma necessarily incident upon surgical intervention could be avoided, that the operative mortality would thus be eliminated, that with a histologic diagnosis the medulloblastomas could be sorted out from other posterior-fossa lesions, and thus

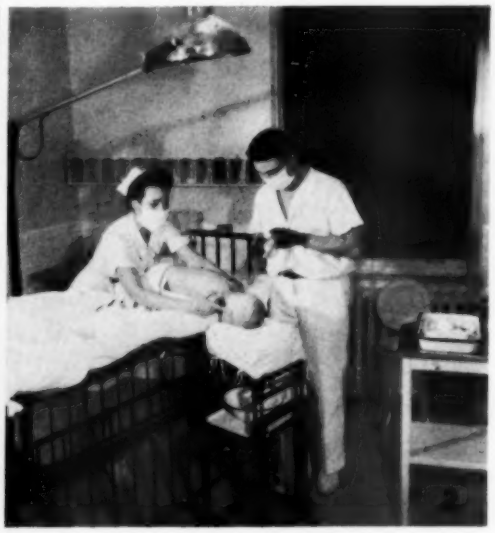

Fig. 1. Twist-drill hole for ventriculography. This procedure is performed in the dressing room immediately prior to ventriculography. The child is postured on a cerebellar head rest with a shampoo-board attachment. No sedation is necessary. One nurse is usually all that is required for restraint. The twist-drill set, seen on the table, includes the twist drill, ventricular needles, syringe and needles for injecting local nupercaine, and a small scalpel.

Pneumoencephalography is always performed prior to the taking of an aspiration biopsy.

Fig. 2. Aspiration biopsy technic. Side view of suboccipital twist-drill immediately prior to the taking of a biopsy. This procedure is also performed in the dressing room immediately off the ward. Exactly identical instruments and equipment are used. In addition, a No. 13 brain biopsy needle is required. Landmarks consist of the midline and the line of the greatest bulge of the occipital bone. The twist-drill opening must be made about 4 cm. lateral to the midline and below the line of greatest prominence to avoid important venous sinuses.

permit immediate institution of roentgen therapy, one of us (W.V.C.), two years ago, began to perform aspiration biopsies on cerebellar lesions which clinically seemed to be medulloblastomas.

Because we believe that aspiration biopsy can be done safely, affording a definite diagnosis in the majority of lesions, and further, that without biopsy many lesions which would respond better to operation than to irradiation would not be sorted out, we cannot agree with Cutler, Sosman, and Vaughan (1936), who favor radiation therapy of suspected cerebellar tumors without histologic diagnosis. Also, with such biopsy, no time would be lost (in fact, some four to ten days gained) in the case of the cystic astrocytomas, in which operation is the treatment of choice.

Children with medulloblastoma are commonly in a serious and very unfavorable condition and are markedly poor operative risks on admission. As noted above, they are usually less than ten years old and their symptoms have gone unrecognized for weeks to months. The five in this particular group (3 girls, 2 boys), varied from nineteen months to eight years of age. Symptoms had been present from one to seven months. Headache and vomiting were exhibited by 4, difficulty in gait by 4. One complained of defective vision, one had a left internal squint.

Upon admission, 3 children were particularly poor operative risks, dehydrated and listless. Four revealed bilateral papilledema, the fifth bilateral optic atrophy. All had an ataxic gait. In 3 cases there was involvement of the pyramidal tracts. Three patients had nystagmus and stiff neck. One exhibited paresis of the fifth and eighth cranial nerves on one side.

VENTRICULOGRAPHIC ORIENTATION

Anatomical location of the tumor was proved in 4 cases by ventriculography.

One very urgent case was subjected to biopsy without a preceding ventriculogram. The air studies in 3 of the children were accomplished on the day of admission, the fourth being done after two days observation in the hospital.

The technic for ventriculography at the Montreal Neurological Institute varies in several points from that used in other clinics. Save for the roentgenographic operations, the entire procedure is carried out in the surgical-dressing room adjoining the ward. The child is postured on a cerebellar head rest (Fig. 1) with shampooboard attachment. Bilateral parietal twist-drill holes are placed 4 cm. from the midline and one-third the distance from the *inion* to the *glabella*. These can be found again easily if ventricular puncture later becomes necessary. Brain needles (No. 18) are placed in the ventricles at the junction of the lateral and posterior horns, the ventricular pressure is measured, and it is ascertained whether or not the ventricles communicate. The ventricular fluid is as completely replaced with oxygen as possible. Roentgenographic studies include the standard positions, but with special manipulation and posing to demonstrate the fourth ventricle.

As soon as the films can be processed and examined, location of the tumor is determined and biopsy is done.

BIOPSY METHOD

The technic of biopsy is simple, providing certain safeguards are observed. The patient is again moved to the surgical-dressing room and postured on the cerebellar head rest (Fig. 2). Under local anesthesia, a twist-drill hole (using a No. 30 drill), similar to the above, is placed halfway between the *inion* and the *mastoid process*, just below the bulge in the occipital bone. Care is thus taken to avoid the lateral sinus. The biopsy material is then withdrawn by means of a No. 15 brain-biopsy needle, inserted not to exceed a depth of 7 cm., directed into the estimated site of the tumor. Biopsy is done *only* if the intracranial pressure is high. This reduces possible complications from a ruptured vessel. We have already called attention to the facility with which this procedure can be accomplished without complications.

The whole neurosurgical procedure, including shaving the head, can be done in less than thirty minutes, and, including the time for roentgenographic exposures and processing, should not exceed an hour. No draping is required, and no more restraint than can be provided easily by a nurse.

In the case of medulloblastomas, the "brain worms" containing tumor, in the gross, are soft in consistency and have a semitranslucent appearance. The tumor material smears very evenly and smoothly on compression between two glass slides. These smears are then stained with Reid's eosin and methylene blue for quick study. Frozen sections can be made and studied if sufficient material is removed. Not uncommonly an amount adequate to permit fixation and imbedding for standard microscopic studies is obtained.

Histologically there are two types of cells (Figs. 3 and 4). Most numerous are the small pear-shaped cells with large darkly staining nuclei and scanty cytoplasm (Fig. 5). These often occur in groups around a vessel or in ball formation (Fig. 6), with their single processes intermingled in the center. The other type (Fig. 7) consists of large tessellated cells with relatively more cytoplasm. These tend to be arranged in a pavement-like fashion. Mitotic figures can usually be observed.

ROENTGEN THERAPY

Upon such confirmation of diagnosis microscopically and determination of the site with, to some degree, the probable size of the tumor, radiation therapy can be instituted intelligently within a very few hours after admission. This is in sharp contrast to the time-consuming and hazardous suboccipital craniotomy and the removal of more or less tumor, with resultant delay of a week to ten days before inauguration of roentgen therapy.

We have advocated for some time

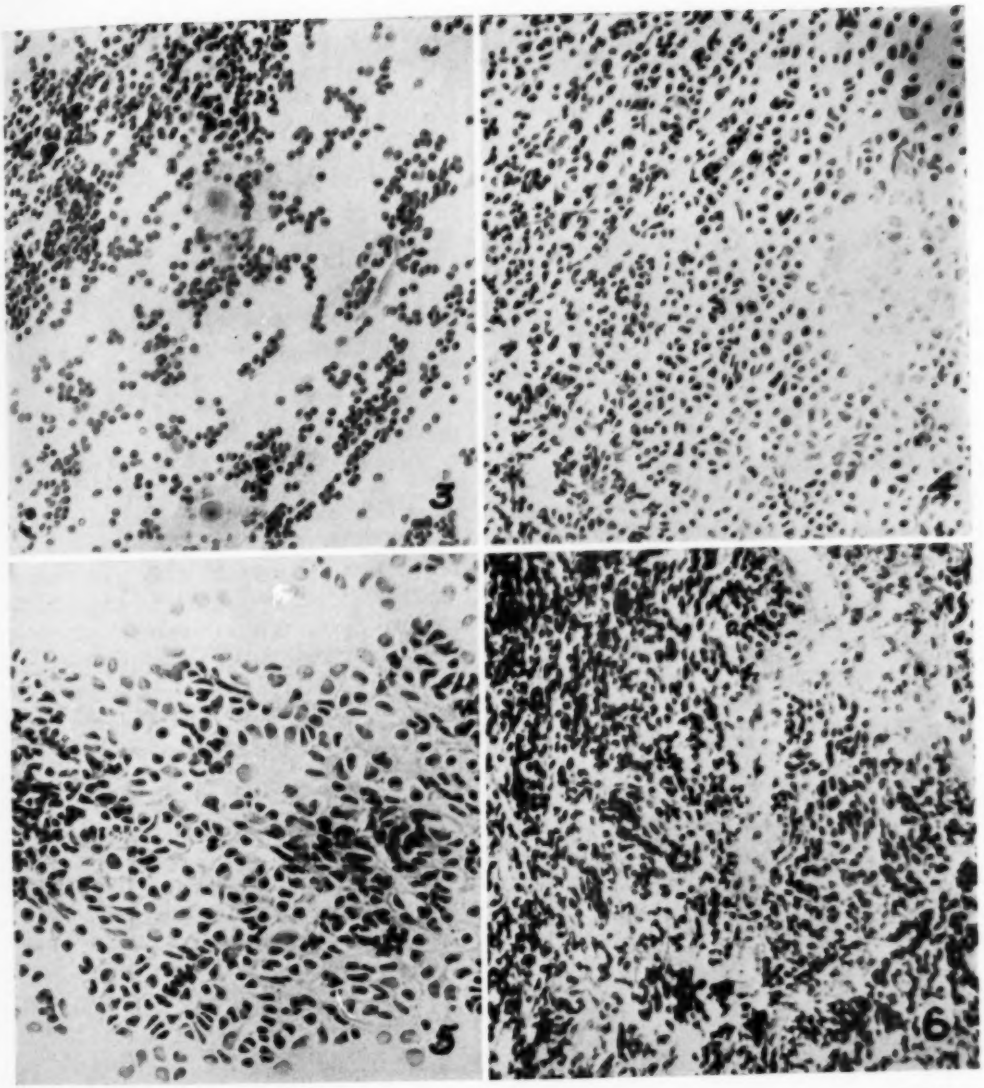

Fig. 3. Normal cerebellar smear. First note the large Purkinje cells with large central nucleus containing a nucleolus. Numerous cytoplasmic extensions of the cell body can be seen. Compare the granule cells of the normal cerebellum with the tumor cells shown in Fig. 4. The normal cells are small, round, of uniform size, and with no tendency to tail formation. There is no characteristic architecture, the cells being spread out in odd clumps.

Fig. 4. Typical medulloblastoma smear (a fairly low-power field photomicrograph). This smear is made immediately on obtaining biopsy material. The suspected tissue is placed between two glass slides, which are pressed firmly together and then drawn apart as for a routine blood smear. Slides are then fixed with heat and stained with Reid's eosin-methylene blue technic, which requires only two minutes.

Fig. 5. Medulloblastoma smear (high-power field). Note the pseudo-rosette at the right of the field. Note also the tendency of the cells to line up in long cords, another architectural pattern often seen.

Fig. 6. Unusual vascular variation (low-power field). This is a somewhat unusual finding in medulloblastomas. Note the increased capillary size and the proliferation of the endothelium.

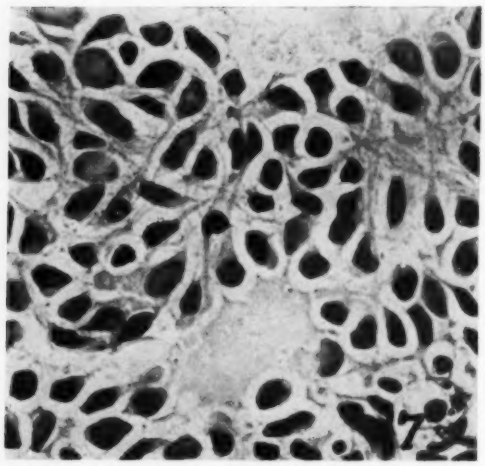

Fig. 7. Medulloblastoma smear (detail view). Note again the peculiarly pear-shaped cells with the eccentric nuclei and long tail processes. The center of the field demonstrates another pseudo-rosette in which the tail processes are intermingled.

"maximum tolerable irradiation." In our institutions, repeated periodic incomplete series giving symptomatic relief have been used in the past as elsewhere, but most unsatisfactorily. We considered that a better method must be devised. Therefore, in view of the relative vulnerability of medulloblastoma, and consonant with our experience and belief as to proper irradiation of brain tumors, we (C. B. P. and J. B.) decided several years ago (late 1940) upon the following program of roentgen therapy.

The primary tumor generally presents no sharp regional demarcation. Because of its location, which is practically occipito-cervical, it tends to protrude through the foramen magnum and extend directly into the uppermost cervical portion of the spinal canal. Loose tumor cells or tumor fragments may spread to any of the subarachnoid spaces above and below the primary lesion and also to the remainder of the ventricular system. This relatively well known fact has a most important bearing on the planning of the size and distribution of ports through which x-radiation is to be delivered, both to the primary tumor and to possible secondary deposits.

For the treatment of the primary area, the most important field is the central occipito-cervical (10 × 15 cm.) with the long axis parallel to that of the cervical spine, the central beam directed sagittally. Generally this port covers the occipital region and not less than the upper half of the cervical spinal cord. We are therefore quite sure that the lower extension of the primary growth is not partially omitted, as it easily might be if one used only a small central occipital field. Routinely, right and left temporo-parieto-occipital ports, 10 × 10 or 6 × 8 cm. each, depending upon the size of the skull, are employed to cross-fire through the tumor and include the basal cisternae and intracerebral spaces. Toward the end of the course, if needed to ease the scalp irritation in other ports, a supraoccipital field (6 × 8 cm.), with the beam directed caudalward, may be added to complete the administration of an adequate tumor dose to the primary area. With exception of the upper cervical portion of the spinal axis, which has already been included in the central occipito-cervical field, the remaining segments of the spinal axis are irradiated with long narrow fields (20 × 6 cm.), down to and including the level of the first sacral vertebra. These spinal fields are usually introduced only upon completion of irradiation of the cranio-cervical portion.

The chief objective is to deliver a tumor dose of not less than 4,500 r to the primary lesion in four weeks. To that effect, doses of 2,200 to 2,400 r, measured in air, are usually given to each of the three major cranial fields specified above. Thus, in the following two weeks, we administer to each segment of the spinal axis 2,000 r, measured in air, with an estimated tumor dose of 1,500 r. Such tumor dose to the spinal subarachnoid spaces may seem small, but the subsequent low incidence of clinical evidence of disseminated tumor development would suggest that this plan is probably adequate to control the rambling cells from medulloblastoma. During the first four or five days of treatment, 100 r only are given daily, to a single port, in order to avoid any undesirable intracranial radiation reaction and systemic upset. Subse-

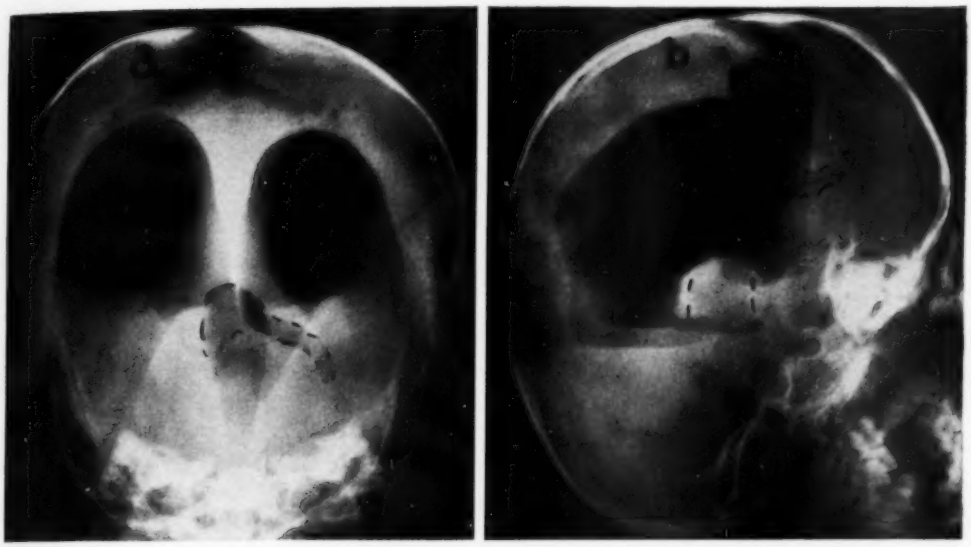

Fig. 8. Baby A, 19 months, was admitted on Sept. 24, 1945, five months after onset of symptoms. She then had stiff neck, bilateral papilledema, paresis of right arm and both legs, and absence of abdominal reflexes. Ventriculograms made the next day show hydrocephalus, with widening of sutures, enlargement of third and lateral ventricles, distortion of aqueduct and absence of outline of fourth ventricle.

Aspiration biopsy on Sept. 26 proved the diagnosis of medulloblastoma.

Roentgen therapy was given to the cerebrospinal axis from Sept. 28 to Nov. 9, 1945. During the last three weeks the child began to play, talk, and move her legs. Papilledema disappeared; size of the head decreased. Readmission for recurrence on April 18, 1946. Second course of x-ray therapy. No post-radiation films were made. Death July 17, 1946, ten months after diagnosis was established and treatment instituted.

quently the same dose is delivered to each of two ports a day, to be increased by the beginning of the second week to 150 r, in air, to each of two ports. When the time comes for irradiation of the thoracic and lumbar segments of the spinal axis, a daily dose of 200 r in air per field is suitable.

The other physical factors are as follows: 200 kv., 50 cm. F.S.D., and Thoraeus filter, producing a beam with a half-value layer of 2.0 mm. Cu, and effective wave length of 0.115 Å.

RESULTS OF ROENTGEN THERAPY

The impressive immediate results in our 5 patients, whose medulloblastomas were definitely diagnosed by the twist-drill biopsy procedure described above, have prompted this preliminary report.

In these children the pattern of roentgen therapy has been that just outlined, delivering to the primary lesion an average tumor dose of 4,600 r and to every level of the spinal axis an average of 1,500 r. Within seventy-two hours, in 3 of the 5, the response was dramatic. They became able to feed themselves, were free of headache and, within a week, acted and behaved like normal healthy children. The 2 others took two weeks to manifest the same degree of improvement. The youngest of the group, who had severe secondary hydrocephalus (Fig. 8) with marked widening of the sutures, presented a very obvious reduction in size of the head as she began to improve. It is to be noted that ventricular taps were necessary in only one case and then only every other day for five days. During the course of treatment none of the children showed any evidence of aseptic meningitis, a complication which occurs every so often in the postoperative cases. Upon completion of their course of roentgen therapy, all showed disappearance of the majority of their symptoms. The bilateral optic atrophy in the one case could not be expected to change.

A further notable point, on completion

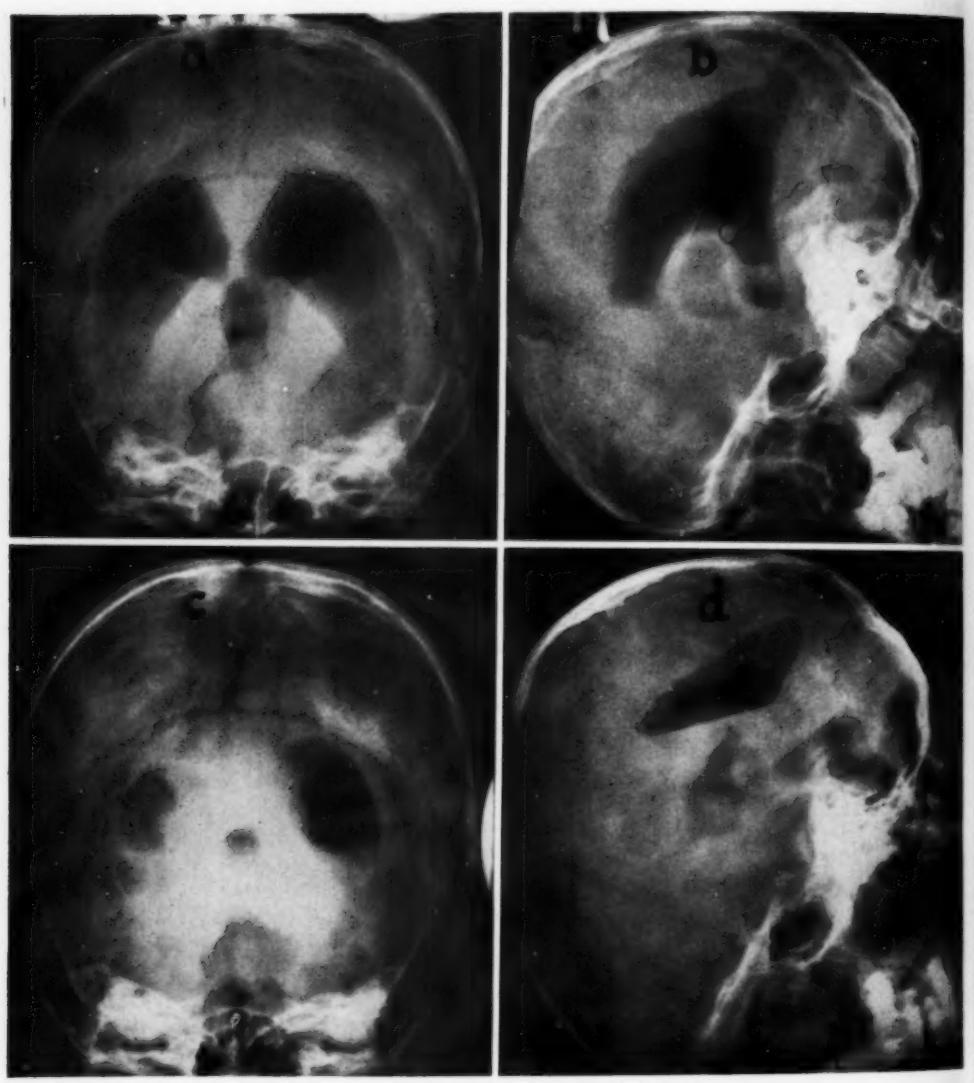

Fig. 9. Lise L., 7 1/2 years, was admitted on March 27, 1947, five months after onset of symptoms, with vomiting, headache, ataxic gait, bilateral papilledema, nystagmus, and left hemiparesis.

a and *b*. Ventriculograms before aspiration biopsy and x-ray therapy, showing dilatation of third and lateral ventricles and absence of filling of the cisterna magna with gas. The triangular outline of the fourth ventricle is almost completely absent, except for part of the right side (anteroposterior view), indicating a space-filling tumor larger on the left than on the right side.

Aspiration biopsy: Medulloblastoma.

From March 28 to May 7, 1947, roentgen therapy was given to the cerebrospinal axis. Symptoms and signs disappeared and the child has remained well ever since.

c and *d*. Pneumoencephalograms immediately after course of roentgen therapy. Note the free communication between spinal canal and ventricular system; clear outline of cisterna magna, fourth ventricle, aqueduct, and most of the third ventricle.

of irradiation, was the pneumo-encephalographic demonstration of regression of the tumor as indicated mostly by the resumption of free cerebrospinal circulation of gas through the upper cervical spinal canal, the fourth ventricle and cisterna magna, and, finally, to the upper cerebral spaces (Figs. 9–11).

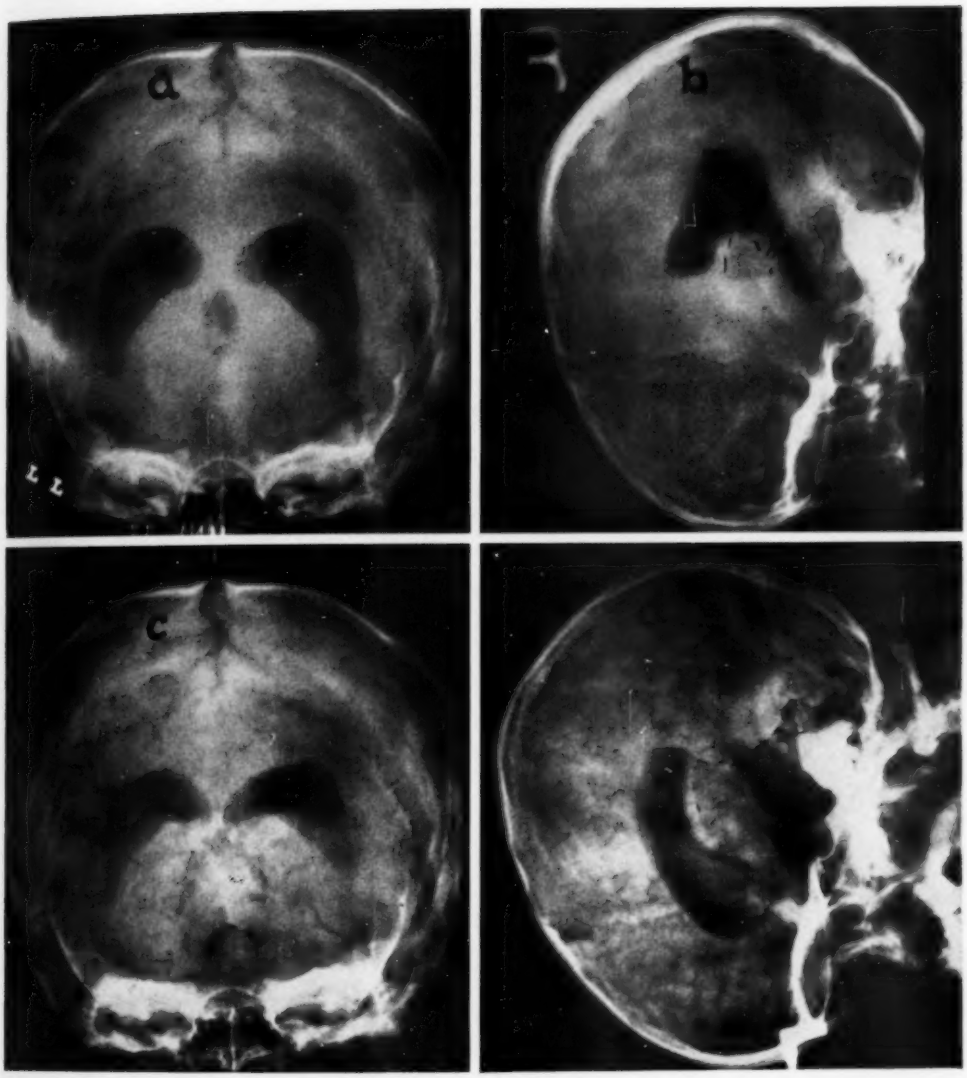

Fig. 10. Miss P, 8 years old, was admitted on June 17, 1947, with headache, vomiting, bilateral optic atrophy, and ataxia. Pneumography was done on the day of admission but the ventricles did not fill. The procedure was repeated successfully on June 19.

a and *b*. Ventriculograms before aspiration biopsy and roentgen therapy, showing slight enlargement of lateral ventricles and, on the lateral projection, blockage of the aqueduct of Sylvius as well as absence of outline of cisterna magna and fourth ventricle.

Immediately afterwards, aspiration biopsy showed a medulloblastoma.

On the same day roentgen therapy was initiated and the entire cerebrospinal axis was irradiated in thirty-seven days. Neurologic signs cleared up except for poor vision and optic atrophy. The patient is still in the same improved condition.

c and *d*. Encephalograms after roentgen therapy, showing apparently normal ventricles. On the lateral projection, made in the "brow-down" position, the cisterna magna was filled with gas, but the fourth ventricle, which usually shows best in this lateral projection, was not seen. On the "brow-up" lateral projection (*d*—shown inverted for comparison), all basal cisternae are nicely outlined, indicating regression of the tumor.

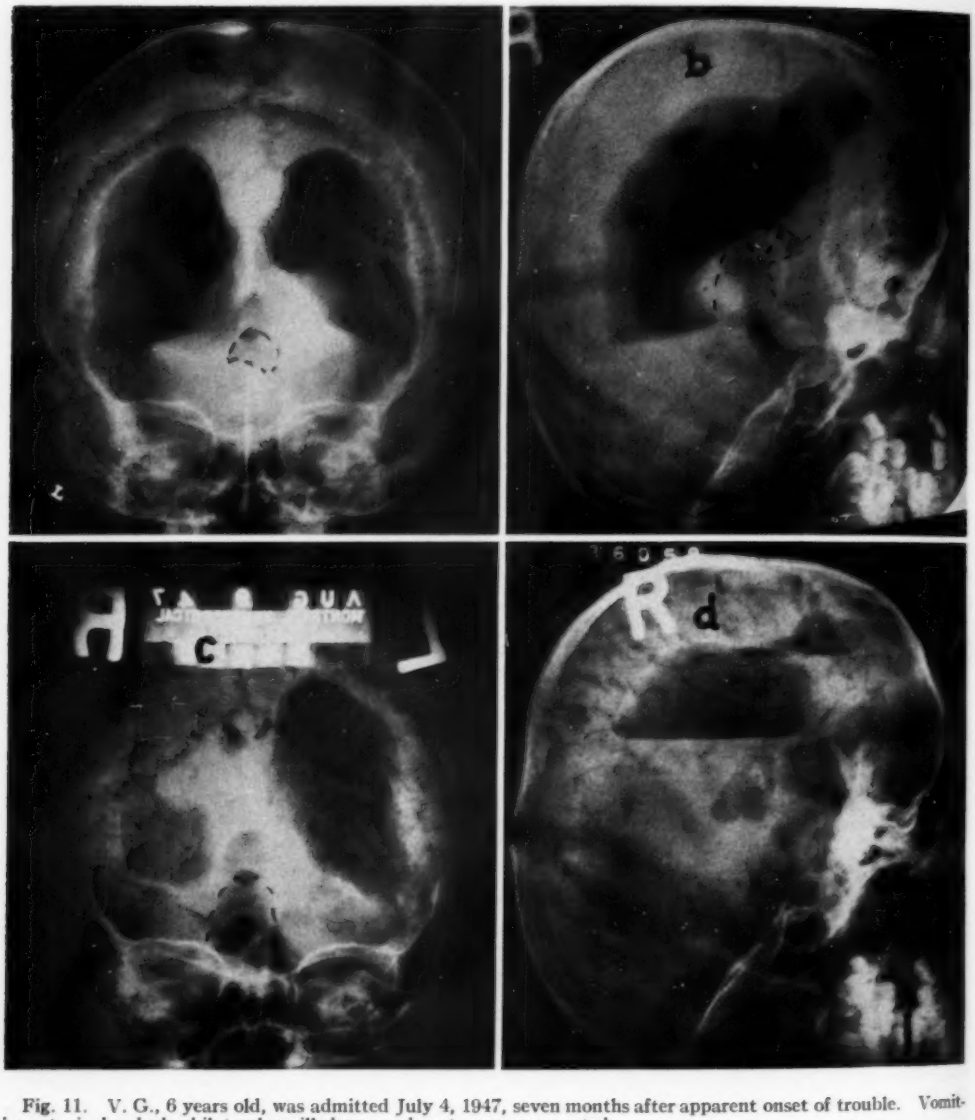

Fig. 11. V. G., 6 years old, was admitted July 4, 1947, seven months after apparent onset of trouble. Vomiting, ataxia, headache, bilateral papilledema, and nystagmus were noted.

a and *b*. Ventriculograms before aspiration biopsy and roentgen therapy, showing widening of cranial sutures, marked enlargement of lateral and third ventricles, and proximal part of aqueduct; absence of proper visualization of cisterna magna and fourth ventricle indicated a tumor located in the region of the fourth ventricle.

Aspiration biopsy was carried out, and the presence of a medulloblastoma was proved.

Roentgen therapy was administered from July 5 to August 11, 1947. On completion of irradiation, papilledema and nystagmus had gone.

c and *d*. Encephalograms after roentgen therapy: free circulation of gas between spinal canal and intracranial subarachnoid spaces, and also into the ventricular system. Cisterna magna is well filled with oxygen, and the fourth ventricle sharply outlined, although the latter seems to be projecting slightly more forward than usual.

The first patient treated by this method is still alive and acting as a normal, bright child at the end of two years, during which he has received two more similar courses of x-radiation, each time because of early signs of tumor recurrence. One of the 2 children whose response to irradiation was slow died nine months later from recur-

rence. This was a babe of nineteen months whose symptoms had gone unrecognized for five months. The other 3 (Figs. 9–11) have been under our observation only nine, six, and four months.

It is too soon, and the number of cases too small, to permit more than a preliminary report on the procedures followed and the immediate results. Only time will tell the real value of our methods.[2] At any rate, each of these 5 patients, who were very poor surgical risks for an operation which carries an average mortality of 25 per cent, had the benefit of a confirmed diagnosis in a most simple way and, as a result of roentgen therapy instituted immediately thereafter, dramatically recovered from a most critical condition. To our thinking, this has been worth while.

SUMMARY

Twist-drill aspiration biopsy of suspected cerebellar lesions can be accomplished simply and safely, but should be done only after careful clinical and ventriculographic orientation of the suspected tumor site. The findings must be so definite as to place the tumor in the posterior fossa.

Such diagnosis of tumor type will sort out the major number of medulloblastomas from other tumors or non-malignant lesions which are better treated surgically. Although some may believe that little is to be gained by biopsy, with the technic described a high percentage of posterior fossa lesions can be identified positively and quickly before the method of treatment is decided upon. Further, at least four to ten days can be gained in the case of an astrocytoma by elimination of the time loss of a therapeutic trial of irradiation.

Within three to four days under roentgen therapy these children are sufficiently improved to repsond more normally. Consequently the improvement made possible in their nutritional state relieves major concern as to their fluid balance and general medical condition. Shortly thereafter they are able to care for themselves in an appreciable degree.

Ventricular tap may be required during the initial days of treatment, but should not be necessary after the fifth day.

Roentgen therapy should be initiated immediately upon diagnosis of medulloblastoma, but conservatively as in all intracranial tumors. The program of treatment should be planned, however, to deliver an adequate tumor dose, in our opinion "the maximum tolerable dose," to the primary area and a considerable portion of such a dose as a prophylactic measure to every level of the spinal axis. This is in contrast to other methods of repeated and oftentimes incomplete irradiation at variable periods.

Royal Victoria Hospital
Montreal 2, Canada

[2] In January 1949, 37 months after initial treatment with x-radiation, the first patient treated by this method was still alive and, in his parents' opinion, well, although he has had recurrences which have been treated in the same manner as originally. The patients whose cases are illustrated in Figures 9 and 10 are alive and well, twenty-two and nineteen months, respectively, after the onset of treatment; they have had no recurrence so far. Patient V. G. (Fig. 11) was clinically well for six months after treatment; then died suddenly as the result of an automobile accident.

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DISCUSSION

Joseph H. Marks, M. D. (Boston): The paper by Dr. Peirce and his associates from Montreal seems to me to record a very definite advance in the management of cerebellar medulloblastomas. I believe there can be little doubt that they have taken a real step forward in their diagnostic procedure, but more time must elapse and a larger number of cases be followed before the wisdom of their choice of dosage is demonstrated. Their first patient had two recurrences within two years in spite of 4,500 r to the primary tumor. Obviously one cannot deliver that dose to the same area very many times. Additional study may indicate that a smaller dose is equally effective.

In defense of my friend and teacher, Dr. Merrill Sosman, I should like to point out that it was his contention that the response to radiation would in itself differentiate between the relatively sensitive medulloblastoma and the resistant astrocytoma. The damage to the patient and the discredit of the procedure derived from the fact that too long a period of time was allowed to pass before the astrocytomas were brought to operation.

Carleton B. Peirce, M.D. (*closing*): I wish to thank Dr. Marks for his comments, but apropos his remarks with respect to Dr. Sosman's opinion, I believe it was he who considered it did not matter whether one takes a biopsy or not. In contrast, one of the points we believe to be important is that the possibility of so simply differentiating astrocytomas with aspiration biopsy will afford a gain of at least ten days in selection for early surgical treatment, and, by the same token, early diagnosis with a minimum of trauma and of delay will afford the child with medulloblastoma the best chance for effective roentgen therapy.

SUMARIO

Meduloblastoma: Tratamiento No Operatorio con la Roentgenoterapia Consecutiva a la Biopsia Aspiratoria

La biopsia aspiratoria con la técnica del taladro salomónico representa un método eficaz en las lesiones cerebelares sospechosas para separar los meduloblastomas radiosensibles de otros tumores o lesiones no malignas que se tratan mejor con la cirugía. Sin embargo, sólo debe practicarse tras la cuidadosa orientación clínica y ventriculográfica del asiento del tumor sospechoso con hallazgos suficientemente precisos para localizar el tumor en la fosa posterior. El procedimiento entraña un mínimo de traumatismo, y por consiguiente mínimo choque y mínimo riesgo de diseminar células neoplásicas, y permite la rápida aplicación del tratamiento apropriado. Tratándose de meduloblastomas, puede iniciarse la roentgenoterapia en término de pocas horas, en marcada contraposición a la demora y el peligro que encierran la craneotomía suboccipital y la extirpación del tejido tumoroso. Si se descubre un astrocitoma, pueden ahorrarse a lo menos cuatro a diez días por la eliminación de un ensayo terapéutico de la irradiación antes de operar.

El esquema de los AA. para la roentgenoterapia en el meduloblastoma, aunque conservador, requiere la "dosis tolerable máxima" en la zona primaria (no menos de 4,500 r en un período de cuatro semanas), y dosis más pequeñas (2,000 r al aire) como profiláctico a cada nivel del eje raquídeo, lo cual contrasta con otras técnicas de irradiación repetida y a menudo incompleta a períodos variables.

Comunícanse cinco casos de meduloblastoma, diagnosticados con la técnica del taladro salomónico y tratados con la irradiación roentgen en la forma descrita. La edad de los enfermos variaba de diecinueve meses a ocho años y la duración de los síntomas de uno a siete meses. Todos los pacientes eran malos riesgos quirúrgicos. La respuesta al tratamiento fué teatral. En término de una semana, tres ya se portaban como niños sanos y normales, mientras que en los otros dos la misma mejoría exigió dos semanas. Sólo en un caso se necesitaron punciones ventriculares durante los días iniciales del tratamiento. Un niño murió de recurrencia a los nueve meses del tratamiento; uno se hallaba vivo y aparentemente bien a los treinta y siete meses, habiendo recibido, entre tanto, más roentgenoterapia por recurrencias; dos se hallaban vivos y bien a los veintidós y diecinueve meses de la iniciación del tratamiento; el quinto murió de otra causa.

Accuracy of Roentgen Diagnosis of Benign Gastric Ulcer[1]

C. A. STEVENSON, M.D.,[2] and C. W. YATES, M.D.[3]

RADIOLOGISTS, surgeons, and clinicians have found through experience that a certain number of gastric lesions diagnosed by roentgenologic methods as benign gastric ulcer have later proved to be carcinomatous. In the medical literature this diagnostic error is quoted as being from 5 to 20 per cent.

From the maze of published material concerning benign gastric ulcer and its relationship to gastric carcinoma, a few conservative opinions may be gathered, although many of these will be argued pro and con until further study clarifies the whole cancer question. Briefly, the points of view expressed in the literature might be summarized as follows:

1. *Nomenclature:* Due to differences in course, prognosis, treatment, and possibly etiology, benign gastric ulcer and duodenal ulcer should be classified separately and not grouped as "peptic ulcers."

2. *Etiology:* Numerous theories have been advanced for the etiology of both gastric ulcer and gastric carcinoma, but the question still remains open.

3. *Incidence of Gastric Carcinoma:* According to the best available figures, approximately 40,000 people die annually in the United States from gastric carcinoma.

4. *Incidence of Malignant Transformation in Benign Gastric Ulcer:* Figures can be quoted from the literature to show (*a*) that cancer rarely, if ever, develops in benign gastric ulcer, (*b*) that it may occur in a few cases, or (*c*) that it occurs in as high as 90 per cent of the cases. Probably the figures of Stewart are most widely accepted. According to these, 9.5 per cent of cases of chronic gastric ulcer become carcinomatous and 17 per cent of gastric carcinomas originate in chronic ulcers. However, several prominent radiologists are of the opinion that gastric carcinoma does not develop from benign gastric ulcer.

5. *Symptomatology:* There is no single symptom or group of symptoms that can be relied upon to differentiate the benign gastric ulcer from the malignant gastric ulcer.

6. *Age and Sex:* Although in a large series of cases the average age for patients with gastric carcinoma will be slightly higher than for those with benign gastric ulcer, this observation is of little value as applied to the individual case. Sex is of no significance in differential diagnosis.

7. *Clinical Laboratory Tests:* At this time there are no laboratory tests which will differentiate between gastric carcinoma and gastric ulcer. The single exception to this statement is the identification of a piece of tumor tissue obtained by gastric lavage, and clinical pathologists are now attempting to diagnose carcinoma of the stomach on the basis of single cells thus obtained. This test is related to Papanicolaou's work on the cytological diagnosis of cancer of the cervix and uterus. Many difficulties can be expected. The pathologist must acquire a great deal of experience in this procedure, and the surgeon may have a real problem if the cytological test reveals cancer cells and the roentgenologic and gastroscopic examinations do not demonstrate a lesion. The degree of gastric acidity is of no differential value in the individual case.

8. *Location of Ulcer:* It is generally agreed that an ulcer on the lesser curvature of the stomach in the mid portion has the greatest chance of *not* being malignant. Prior to 1936, it was believed that ulcers occurring in the prepyloric region showed

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[1] Presented before the Texas State Radiological Society, at its Annual Session, Temple, Tex., Jan. 17, 1948. Accepted for publication in April 1948.

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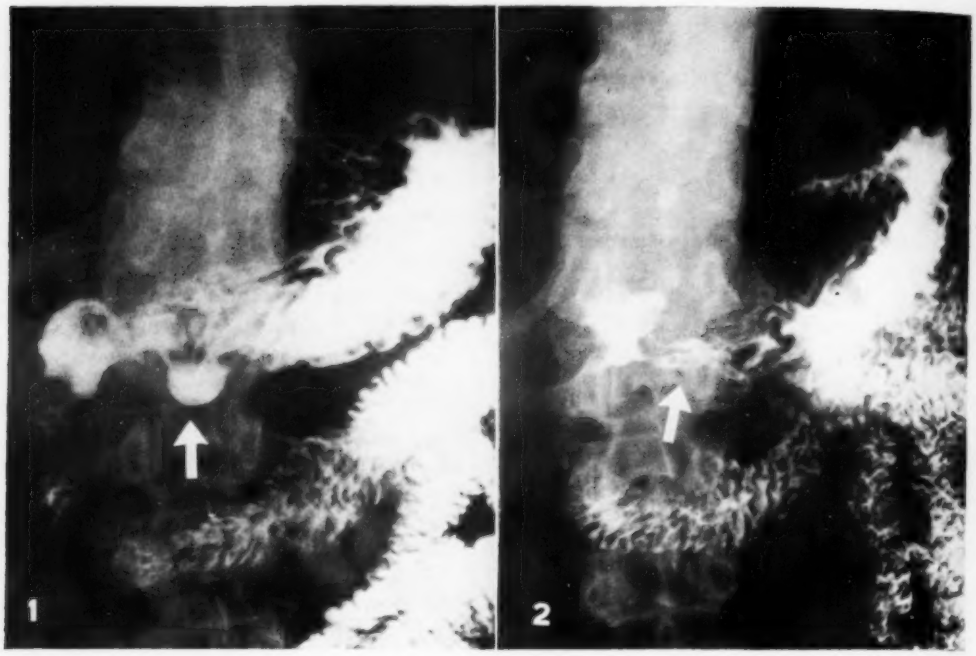


Fig. 1. Syphilitic ulcer in the distal third of the stomach, on the greater curvature side.
Fig. 2. Complete disappearance of ulcer crater after thirty days of antisyphilitic therapy.

a higher incidence of malignancy. However, following the work of Singleton (1), later confirmed by Kirklin and MacCarty (2), the opinion now held is that the probability of malignancy in a roentgenologically demonstrable ulcer in the prepyloric region is no greater than in an ulcer in another site in the stomach. A warning should be sounded here that the opinion still exists that four out of five prepyloric "lesions" are malignant. Ulcers on the posterior wall distant from the lesser curvature are prone to be malignant and approximately 96 per cent of those on the greater curvature are malignant. The list of reported benign gastric ulcers on the greater curvature is increasing, especially in association with positive serologic tests for syphilis (Figs. 1 and 2).

9. *Size:* MacCarty (3) has done considerable work with reference to the relationship between the size of a gastric ulcer and malignancy. He has shown, and his view is widely accepted, that an ulcer measuring 2.5 cm. or more in diameter is very likely to be malignant. However, size alone cannot be taken as a criterion, as approximately 6 per cent of resected carcinomas are less than 2.5 cm. in diameter, and many benign ulcers attain larger dimensions.

10. *Medical versus Surgical Treatment:* With the improvement in the mortality rate for gastric resection, there is an increasing number of surgeons who advocate immediate surgery for all gastric ulcers. They argue that, inasmuch as 10 to 12 per cent of gastric ulcers diagnosed as benign by roentgenologic methods are actually malignant, while the mortality rate for resection is much lower than this, surgical treatment should be employed as soon as possible. The medical clinicians argue that less than 10 per cent of ulcers are malignant and a therapeutic trial of conservative measures should be given, with strict criteria for healing, prior to surgery. They also cite the growing number of surgical "cripples" following resection as an argument against immediate surgery in all

cases. Criteria for healing of an ulcer under rigid observation have been set up: (1) complete healing as shown by roentgenologic examination, (2) disappearance of all symptoms, (3) absence of occult blood in the stools.

11. *Gastroscopy:* To all but a few enthusiasts, gastroscopic examination is viewed as a supplement to roentgenologic examination rather than a rival method. Given a lesion of the stomach visible by the gastroscope, this method is slightly more accurate than roentgen examination. However, gastroscopy alone is probably no more accurate, and is more complicated and more dangerous to the patient, than roentgenologic examination.

12. *Roentgenologic Examination:* Kirklin (4) has aptly stated the service rendered by roentgenologic study of the stomach as follows:

(1) As a rule, it can be relied upon to disclose any existing ulcer regardless of manifestations.
(2) It has a proportionate exclusion value when clinical data indicate the presence of an ulcer.
(3) It demonstrates the exact site of an ulcer.
(4) It will determine the presence or absence of complications.
(5) It will reveal the number, depth, and surface extent of ulcers.
(6) It will distinguish, or assist materially in distinguishing, ulcers from other lesions, and benign from malignant lesions.

ROENTGENOLOGIC SIGNS OF ULCER

The basic sign of an ulcer is the barium-filled crater, the niche, or its exaggerated form, the accessory pocket. When the ulcer is situated favorably and is seen in profile, it appears as a bud-like prominence projecting from the barium-filled stomach. It commonly projects beyond the normal line of the gastric lumen. When seen face on, with the gastric walls approximated, the crater appears as a rounded dense spot amid the rugal markings, with the rugae commonly converging on this spot.

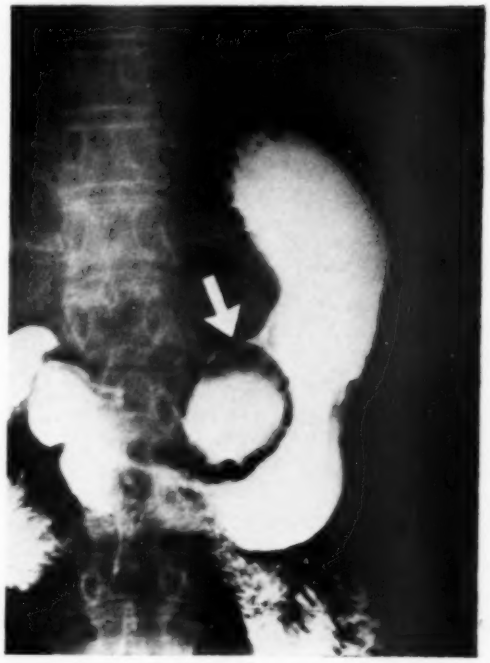


Fig. 3. Large meniscus sign due to metastatic melanoepithelioma, primary on the left leg.

Secondary manifestations are usually present, but unless the crater can be demonstrated, a diagnosis of ulcer is not justified. Accentuated and irregular gastric rugae about the ulcer, tenderness to pressure over the region of the crater, active peristalsis and gastrospasm in various forms are commonly observed. Curling of the pyloric end toward the midline, with the stomach assuming a hook form, and an eccentric position of the pyloric canal have also been listed as secondary findings. We have observed the latter condition so frequently without evidence of pathologic change in the stomach that it is difficult to attach much significance to it.

In differentiation, the malignant ulcer usually has a demonstrable elevation of the border about the ulcer; the ulcerous cavitation is within the normal line of the gastric lumen; the margins are often irregular and undermined, and the surrounding rugae may be effaced. The adjoining gastric wall may be infiltrated and appear

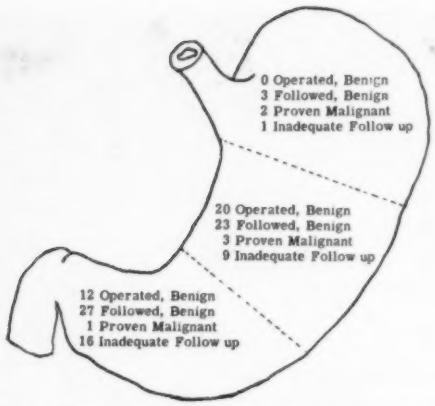


Fig. 4. Arbitrary division of the stomach into thirds for localization purposes.

stiffened. The secondary manifestations are less likely to be present with a malignant ulcer, tenderness to pressure being less evident and gastrospasm being less frequent. If the ulcer projects beyond the normal limits of the gastric lumen and has an accessory pocket, it is not likely to be malignant. The meniscus complex described by Carman (5) is pathognomonic of an ulcerating cancer, but not necessarily one primary in the stomach (Fig. 3).

SERIES OF 117 ULCERS

The series of gastric ulcers presented here consists of 117 consecutive cases diagnosed roentgenologically, by various examiners in the Department of Radiology at the Scott and White Clinic, as benign gastric ulcer. Only those cases are included in which the roentgenologist reported a simple benign gastric ulcer. Cases in which some sign suggesting malignancy was found were discarded. Ulcer size and location were not taken as indicative of malignancy.

Because of the confusion existing in the literature concerning the anatomic divisions of the stomach, we have divided it, for purposes of localization, into three parts (Fig. 4). Of the 117 ulcers in this series, 6 (5.12 per cent) were located in the upper third of the stomach, 55 (47 per cent) in the middle third, and 56 (47.86 per cent) in the lower third (Fig. 4.)

Ninety-one cases have been followed for periods ranging from ten months to twenty years, while follow-up was inadequate in 26 of the cases. Thirty-two lesions were proved to be benign by pathological examination of tissue at the time of surgery plus subsequent roentgenologic examination; 53 patients have been followed by letter and/or subsequent roentgenologic examinations for periods ranging from ten months to twenty years without signs of malignancy; in one patient a gastric carcinoma developed six years after proved diagnosis of ulcer; 6 cases were proved malignant by operation, the surgery being performed at periods varying from a few days to six months after diagnosis. *Twenty* of the ulcers were larger than 2.0 cm. in diameter, and only 2 of these, or 10 per cent, were subsequently proved to be malignant.

In only 2 of the 6 cases proved to be malignant did the x-ray report mention the possibility of malignancy, and then only because of the size of the lesion. A third patient was operated upon immediately and a pathologic diagnosis of benign ulcer was made, but this diagnosis was reviewed and changed to lymphosarcoma of the stomach six months later when the patient returned with a lymphosarcoma of the small intestine.

The 6 cases in which the roentgenologic diagnosis was wrong represent an error of 5.1 per cent in the series of 117 cases, or a corrected error of 6.6 per cent of the 91 cases with adequate follow-up.

CASE REPORTS

CASE I: H. A., white male, age 58, was first seen in 1941 complaining of diarrhea of three years duration, with eight to ten stools daily. There was no cramping, tenesmus, or melena. Stools were light-colored and watery in consistency. The patient had lost 25 pounds, but there were no gastric symptoms. Positive findings were a non-functioning gallbladder and questionable colitis. Gastric analysis: Free acid 52, combined acid 11, total acid 63. X-ray examination of the stomach did not reveal any pathologic change.

The patient was seen twice in 1942; at these times diarrhea had recurred but was easily controlled. In September 1944, he returned, com-

plaining of pain, of three months duration, in the left upper quadrant. The pain was relieved by alkalies and exaggerated when the stomach was empty.

Laboratory examinations revealed no abnormalities. Gastric analysis: Free acid 54, combined acid 9, total acid 63.

The report of the x-ray examination of the stomach was: "Duodenal ulcer. There is a gastric ulcer in the pyloric end of the stomach on the posterior wall, with marked hypertrophy of the gastric rugae in the upper half of the stomach." (Fig. 5.)

The patient was hospitalized for treatment and the following x-ray report was made twelve days later: "The changes in the pyloric end of the stomach are more marked than on previous examination and it is impossible to rule out an ulcerating malignancy."

A gastric resection was performed, at which time the pathologist reported "three chronic benign gastric ulcers with diffuse gastritis."

In January 1945, the patient complained of some urinary symptoms. X-ray examination of the stomach showed a normally functioning anastomosis.

The patient returned in April 1945, with a lower abdominal mass which proved, on exploration, to be lymphosarcoma. Review of the pathological slides made at the time of gastric resection resulted in a change of diagnosis to lymphosarcoma of the stomach. Death ensued two months later.

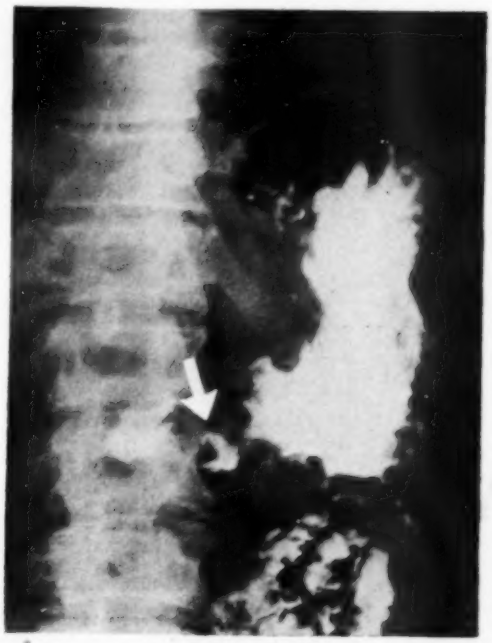
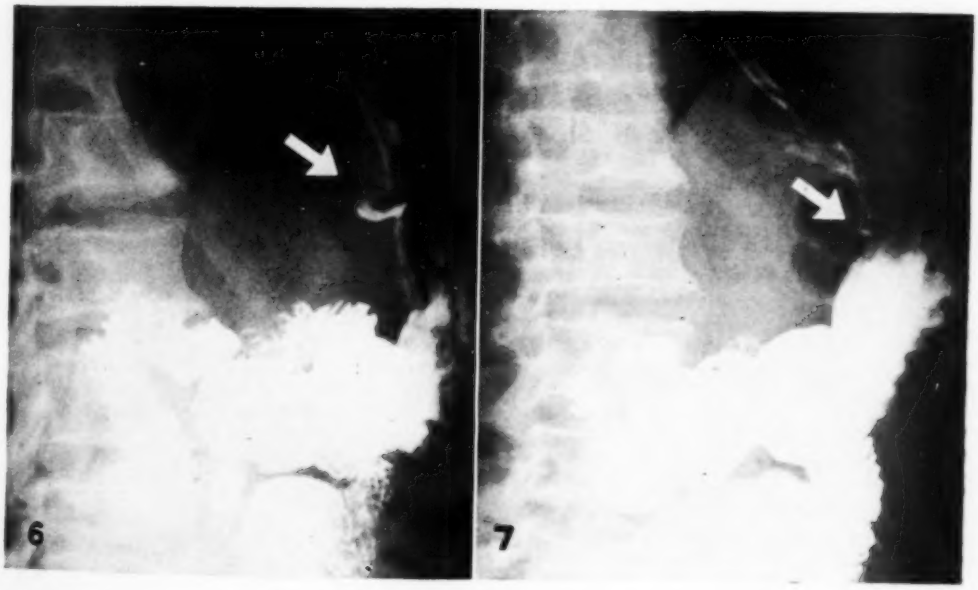


Fig. 5. Case I. Irregular gastric ulcer in the pyloric third.



Figs. 6 and 7. Case II.

Fig. 6. Penetrating type of ulcer in the upper third of the stomach. The crater projects well beyond the normal gastric wall.

Fig. 7. After six weeks of medical ulcer therapy, the crater is smaller but still present. At this time the roentgenologist is still forced to make a diagnosis of benign gastric ulcer, but a consideration of the criteria for healing should make the clinician highly suspicious of malignancy.

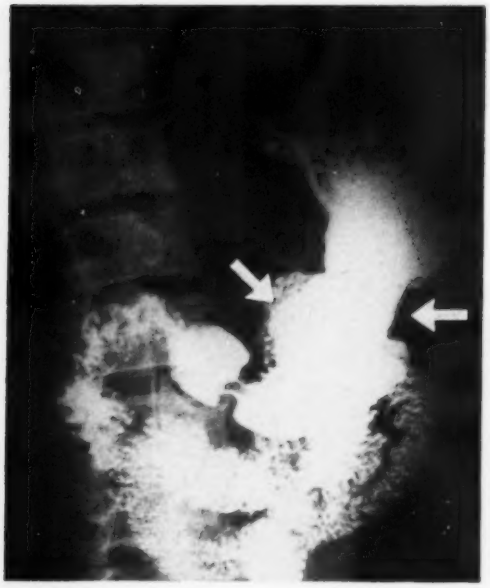


Fig. 8. Case III. Ulcer on lesser curvature side of the middle third of the stomach. Note area of spasm on the greater curvature side opposite the ulcer. This is usually found only in association with a benign ulcer.

CASE II: C. H., white male, farmer, age 57, was first seen in March 1944, complaining of weakness of one month duration. He had fainted while visiting his home physician and subsequently received medication for anemia. Three weeks previously he had vomited bright red blood and had passed dark stools since that time. There had been anorexia and a 10-pound weight loss in the past month.

Serologic tests were negative. The red cell count was 4,120,000; white cell count 13,200; hemoglobin 66 per cent. The urine was negative. The sedimentation rate was 55 mm./hr. Roentgen examination showed "a penetrating type of ulcer with a crater measuring 1 × 2 cm. on the posterior wall of the upper one-third of the stomach." (Fig. 6.)

The patient went home, on an acute ulcer regime, and returned six weeks later. X-ray examination showed the ulcer still present, but smaller than at previous examination (Fig. 7). Surgery was advised. The surgeon's opinion was benign ulcer, and frozen section confirmed this, but later microscopic study showed an ulcerated adenocarcinoma, grade III, with almost complete penetration of the posterior wall but with no evidence of lymph node metastasis.

CASE III: L. R. S., white male, farmer, age 54, was seen in October 1944, complaining of epigastric pain for the past ten months, which had no relationship to meals and was unrelieved by alkalies. Physical examination and laboratory examination revealed little of significance.

X-ray examination revealed a non-functioning gallbladder. In the stomach there was a defect on the posterior wall in the middle third, which was thought to represent a gastric ulcer (Fig. 8).

Hospitalization with a strict medical regime was advised. If no improvement occurred, surgical exploration was to follow. This advice was refused and the patient returned home.

Follow-up letters reported several episodes of hematemesis. The patient was operated upon elsewhere, in July 1945, at which time an adenocarcinoma of the stomach was found.

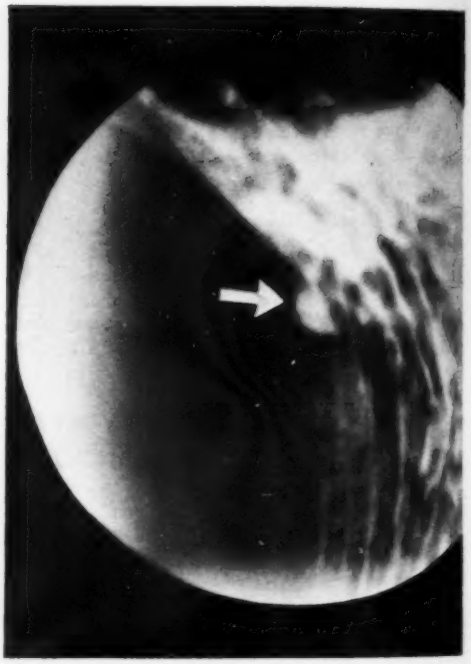


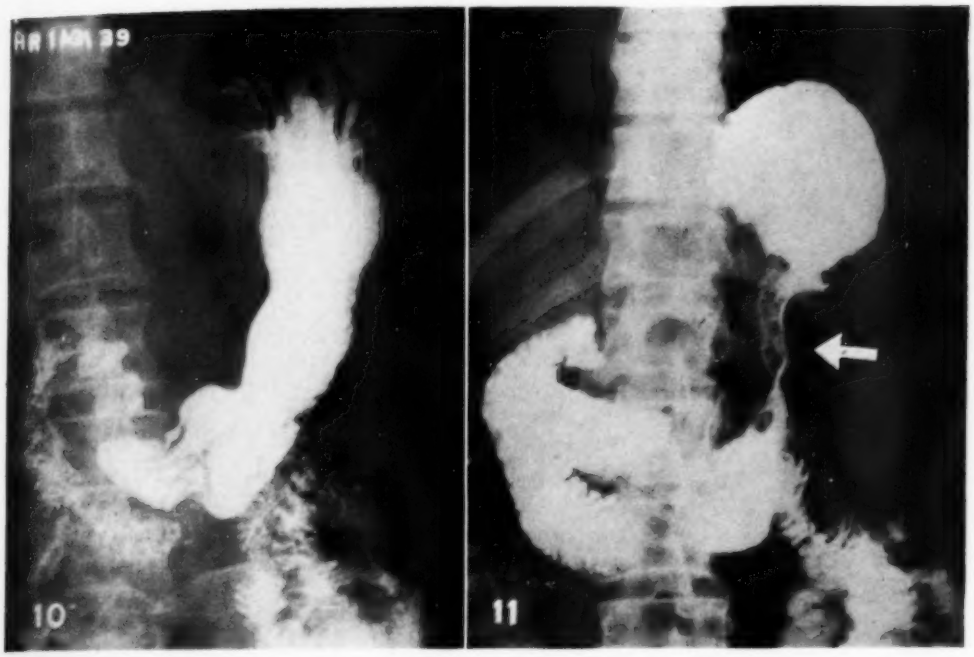
Fig. 9. Case IV. Typical benign gastric ulcer on lesser curvature side in the upper third of the stomach. See also Figs. 10 and 11.

CASE IV: Mrs. C. W., white female, age 53, was first seen in December 1941, complaining of stomach trouble. Six months previously, following strenuous exertion, she had had an attack of vertigo and became nauseated. Following this she passed large tarry stools. Dark stools were noted daily, up to the time of admission.

Physical examination and laboratory tests were non-contributory except for a mild anemia. Gastric analysis showed free acid 37, combined acid 15, total acid 52.

The x-ray report read: "There is a small gastric ulcer 1 cm. in diameter, high on the lesser curvature near the cardia. This is a typical benign ulcer but the location is unusual." (Fig. 9.)

The patient was advised to remain under observa-



Figs. 10 and 11. Case IV.
Fig. 10. Complete disappearance of ulcer shown in Fig. 9 after thirty days of medical treatment.
Fig. 11. Large carcinoma, the proximal border of which is near the site of the original ulcer (Fig. 9). This is five months after healing of the ulcer was demonstrated.

tion in the hospital for two weeks, with re-examination at the end of that time. She refused, went home, and returned for observation Jan. 9, 1942. X-ray examination at that time showed a slight defect at the site of the previous ulcer, interpreted as scarring from that process. The ulcer was apparently healed (Fig. 10).

The patient returned June 21, 1942, six months following the original examination, stating that three days previously she had had another attack of vertigo followed by tarry stools. She had lost 17 pounds since the last visit. X-ray examination revealed extensive scirrhous carcinoma involving the middle third of the stomach (Fig. 11). Surgical exploration on July 1, 1942, showed "fibrocarcinoma of *linitis plastica* type, grade III, of the mid portion of the stomach, with some involvement of the perigastric lymph nodes."

CASE V: W. W. McC., white male, age 72, a college instructor, was first seen in July 1938, complaining of epigastric pain of eighteen months duration, with gradual loss of weight. He had had considerable vomiting but no hematemesis or melena.

X-ray examination after lavage and antispasmodics was reported as follows: "The stomach contains a large amount of secretion. Unable to get any barium through the outlet of the stomach. There is a persistent defect on the lesser curvature of the stomach which is consistent with a large gastric ulcer that may be malignant." (Fig. 12.)

Surgery was advised but was refused, and the patient returned home. He was operated upon elsewhere six months later and died at the time. Operative findings were extensive carcinoma involving the entire stomach and lymph nodes, with peritoneal implants and nodules in the liver.

CASE VI: P. E. E., white male, age 46, farmer, was first seen in March 1945, complaining of abdominal pains of four to five years duration. Pain had increased recently but was relieved by milk.

X-ray examination showed "a large penetrating gastric ulcer high on the lesser curvature; the ulcer is about 5 cm. in diameter and because of its size, malignancy should be considered. Marked hypertrophy of the gastric rugae." (Fig. 13.)

On surgical exploration, a carcinoma of the stomach with lymph node metastases was found.

CONCLUSIONS

1. The experienced radiologist is able, by adequate fluoroscopic examination, to be highly accurate in the diagnosis of benign gastric ulcer.

2. In a series of 91 adequately followed

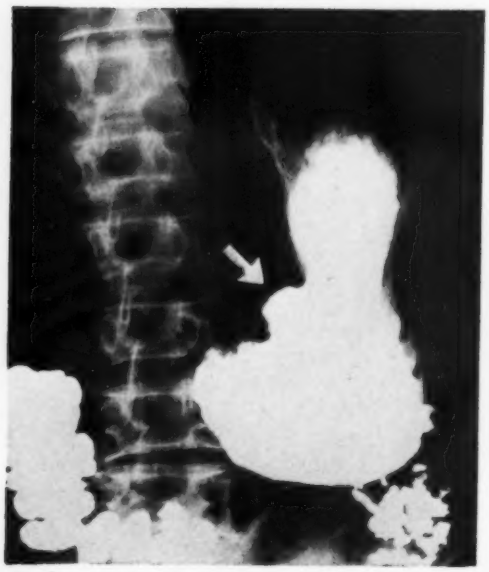


Fig. 12. Case V. Large ulcer on lesser curvature side, in the middle third of the stomach.

gastric ulcer patients, the roentgenologic report of a benign lesion was accurate in 93.4 per cent.

3. In spite of various criteria for the differential diagnosis between benign gastric ulcer and gastric carcinoma, we are unable, on reviewing the roentgenograms and the fluoroscopic findings, to find any difference in the six malignant cases erroneously diagnosed as benign, as compared to the proved benign ulcers in this series. We believe, therefore, that it is impossible, at any one roentgenologic examination, to definitely differentiate a gastric ulcer from a gastric carcinoma. However, if adequate criteria for benignancy are kept in mind, this single procedure is about as accurate as any test in the field of medicine.

4. No particular fault can be found from a roentgenologic standpoint, with either the medical or surgical procedures needed to enhance the accuracy of the roentgenologic diagnosis. However, since it is a well known fact that a roentgenologic diagnosis of gastric carcinoma implies a very poor prognosis, it may be wise to consider seriously immediate surgery for

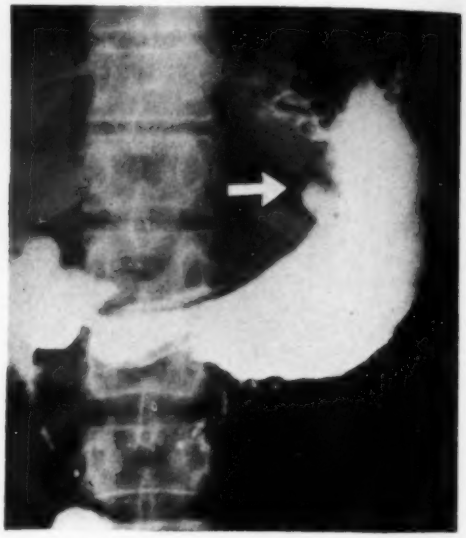


Fig. 13. Case VI. Large broad-based ulcer on lesser curvature in the upper third of the stomach.

all cases of roentgenologically diagnosed benign gastric ulcer, in the hope of early removal of the carcinoma in the approximately 10 per cent of cases in which the diagnosis is wrong.

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SUMARIO

Exactitud del Diagnóstico Radiológico de la Ulcera Gástrica Benigna

En una serie de 91 enfermos con úlcera gástrica, mantenidos en observación adecuada, el informe roentgenológico de lesión benigna resultó exacto en 93.4 por ciento. Las historias de los seis casos que resultaron malignos aparecen aquí.

A pesar de varias pautas para el diagnóstico diferencial entre úlcera y carcinoma del estómago, los AA. no pueden, después de repasar las radiografías y los hallazgos roentgenoscópicos, encontrar la menor diferencia en los seis casos malignos, diagnosticados erróneamente como benignos, comparados con los de úlcera benigna comprobada en la serie. Creen, pues, que es imposible, con ningún examen roentgenológico, diferenciar definitivamente una úlcera gástrica de un carcinoma gástrico. No obstante, si se tienen en mente pautas adecuadas para la benignidad, este procedimiento viene a ser tan exacto como cualquiera de las otras pruebas utilizadas en la medicina.

Siendo bien sabido que un diagnóstico roentgenológico de carcinoma gástrico denota un pronóstico muy malo, acaso sea prudente considerar con seriedad la cirugía inmediata en todo caso de úlcera gástrica benigna diagnosticada roentgenológicamente, con la esperanza de extirpar cuanto antes el carcinoma en el 10 por ciento aproximado de casos en los que el diagnóstico es erróneo.

Fibrous Dysplasia of Bone (Monostotic)[1]

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FIBROUS DYSPLASIA occupies a rather prominent position among those bone lesions which frequently owe their detection to an incidental radiologic examination. In the absence of subjective symptoms or objective clinical findings, the radiologic evidence is then the only indication of skeletal disease. The accuracy of the radiologic diagnosis is not well established, and many investigators have expressed the view that the roentgen findings are not specific and therefore not reliable. Schlumberger (20) emphasized the fact that in none of the sixty-nine cases studied by him at the Army Institute of Pathology during World War II was the possibility of fibrous dysplasia entertained by the radiologist.

Our experience at Brooke General Hospital has led us to believe that the diagnosis can be arrived at with relative ease on the basis of the radiologic appearance of fibro-dysplastic lesions. Our observations do not indicate, however, that the radiologic features of fibrous dysplasia are always specific or pathognomonic. It is our intent in this presentation to review proved cases of monostotic fibrous dysplasia observed at this hospital during the last two years and to discuss the most frequent and relevant roentgen diagnostic criteria.

HISTORICAL

This relatively common bone lesion has had many diagnostic terms applied to it in the past. The most frequently used include: "osteitis fibrosa cystica localisata," "fibrocystic disease of bone," "bone cyst," "osteodystrophia fibrosa," "fibro-osteoma," and "fibroma of bone." Other unrelated conditions have also been thought to belong to this group of bone diseases.

The clinical syndrome characterized by multiple bone involvement, pathological pigmentation of the skin, and precocious puberty in the female was described in this country by McCune and Bruch (16) and also by Albright and his associates (1). It was to the bone lesions in this syndrome that Lichtenstein (14) first applied the name "fibrous dysplasia." In a subsequent publication by Lichtenstein and Jaffe (15) the term was extended to include those cases of monostotic involvement in which the bone lesion showed the same histologic characteristics but there were no extraskeletal manifestations. These writers expressed the opinion that the two varieties, monostotic and polyostotic, represented different degrees of severity of the same pathological entity and suggested that the basic disorder was due to perverted activity of the specific bone-forming mesenchyme.

Further contributions to our understanding of this disease have been made by Furst and Shapiro (8), Pugh (17), Windholz (23), Wyatt and Randall (24), and others.

MATERIAL STUDIED

During the period of this study 22 cases of monostotic fibrous dysplasia have been observed. Nine of these cases were proved by biopsy. In the remaining 13 cases no histopathological confirmation of the radiologic diagnosis was obtained, since biopsy or operation was not indicated clinically. Three additional cases were erroneously diagnosed as fibrous dysplasia. This analysis is based on the proved cases only.

CLINICAL MANIFESTATIONS

The clinical history is variable. In a number of cases the onset of symptoms was related to some specific trauma; in others a gradual onset without preceding trauma was recorded. In 5 of our series of proved

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cases there was a history of a previous injury, usually not severe, incurred long enough (six months to two years) prior to diagnosis of the lesion to be of significance. In 2 cases the trauma occurred immediately prior to the radiologic examination at which the lesion was demonstrated. The remaining 2 cases gave a history of gradual onset of localized pain and swelling at the site of bone involvement. In one of the latter cases the symptoms were of several weeks duration while the other patient's complaints began ten months earlier. In none of these cases had an attempt been made to verify the presence or absence of bone injury roentgenologically, either at the time of the original trauma or subsequently, until the examination at which the lesion was revealed.

Persistent pain, though usually not severe, was noted in all of our proved cases of fibrous dysplasia. Four patients had a pathological fracture to account for the pain. Several of the unproved cases were asymptomatic. The next most common symptom was swelling, which was present in 3 cases, but in only one was the swelling of any considerable degree (Case 1). This patient showed the most extensive bone involvement, and the lesions were demonstrably progressive. Local tenderness occurred in only one case. No patient showed any of the extraskeletal manifestations commonly associated with polyostotic fibrous dysplasia (1). The period of observation was relatively short in the majority of cases, ranging from one month to twelve years. No patient showed leukocytosis, fever, or elevated sedimentation rate to suggest infection. The blood chemistry determinations were normal. The serology was negative.

ROENTGENOLOGIC ASPECTS

The roentgenographic features of fibrous dysplasia recur with sufficient frequency that, when observed, a probable diagnosis can be established. These features include: (*a*) the site of the lesion, (*b*) new bone formation within the lesion, (*c*) the relation of the lesion to the surrounding bone, (*d*) the occurrence of multiple lesions within a single bone, and (*e*) the ensuing deformity.

Lesions of fibrous dysplasia have been reported as occurring in practically every bone of the skeleton, though ribs and the long bones of the extremities are most frequently affected. The bones of the lower extremity are apparently a particularly favorite site of involvement. This was true of our cases, in which the lesions were limited to the lower extremities (Table I). The lesions within the bone are located in the metaphysis or diaphysis, the exact site presumably depending somewhat on the time interval from their development in the growing skeleton to their roentgenographic discovery. The epiphysis is probably never primarily affected by a fibrodysplastic bone lesion. Albright (2) states that he has never seen the epiphysis involved. Caffey (4) also, in his discussion of "bone cysts," lays stress upon their failure to extend into the epiphysis. A juxtaepiphyseal focus in the metaphysis may extend through a closed epiphyseal line, though in none of the cases in this series did this occur.

The area of involvement is characteristically sharply demarcated from the adjacent normal bone. The junction may show a zone of increased density, which is attributed by Sante (18) to compression of the cancellous structure. This is more frequently observed in the small solitary lesion than in the more extensive areas of involvement. The lesion is practically always eccentrically located and involves the cortex and the medulla, the former being encroached upon from its endosteal surface. Sante (18) stated that the point of origin is in the cortical layer, as indicated by the crescentic character of the involved area, with the base at the cortical margin, though the lesion may give the impression of being medullary in location when seen at right angles. Subperiosteal development of the lesions of polyostotic fibrous dysplasia has been reported (7). The larger lesions expand the cortex to a variable degree.

The longitudinal growth of the long bones is practically never disturbed in cases with small lesions but with extensive involvement there may be initial accelerated growth followed by premature closure of the epiphysis. Periosteal reaction occurs only at the site of a pathological fracture. The cortex may become thinned almost to the point of disappearance, but true penetration does not occur. During the period of skeletal growth, there may be deposition of bone adjacent to the lesion, extending above and below for a variable distance as a physiological reaction to the localized weakening of the bone. This is demonstrated in the early stages of Case 1 (Fig. 1A).

Within the lesion proper there is a loss of normal bone density as a result of replacement of the osseous structures by fibrous tissue. The concomitant minute metaplastic bone spicules within the fibrous stroma cause a homogeneous increase in density which has been described as a "ground glass" (13) or "smudged" appearance (19). This has been especially emphasized by Wyatt and Randall (24) as one of the most distinctive features. Not all cases in this series showed this picture. It was noticeably absent in the earliest film made in Case 1, suggesting that it may develop only as the lesion becomes older. In the absence of this diffuse "smudge," the differentiation of fibrous dysplasia from non-osteogenic fibroma (10) may be impossible. Perhaps such a distinction is not of special value if Schlumberger (20) is correct in his belief that non-osteogenic fibroma is merely a variant of fibrous dysplasia. Another feature of fibrous dysplasia is the presence of coarse columns or trabeculae of bone protruding into the lesion from the periphery and giving it a multilocular appearance. Bones extensively involved by multiple, coalescing lesions show marked irregularity of density, varying from that of soft tissue, where sections without intrinsic calcification are seen tangentially near the surface of the cortex, to the eburnated appearance of thick sections of compact bone where the lesions overlap and fractures have occurred with subsequent healing.

Surrounding the area of fibrosis is a zone of increased but variable density. In contrast to the sharp demarcation at the border next to the lesion, the periphery often shades into normal bone. Wyatt and Randall (24) call attention to the common occurrence of a prolongation of this zone at a single point in the periphery, giving a tongue-like configuration which has been compared to a candle flame. This zone of increased density varies in width. It is more evident in smaller lesions and tends to become wider with the development of the lesion. This is demonstrated in Case 1, which shows minute, newly developed lesions with no border of increased density and older ones with wide dense borders. Sante (18) points out that this represents compression of the adjacent cancellous bone without true bone sclerosis. Exclusive of the areas of involvement, the bone is of normal density. Cases with extensive involvement show marked deformity resulting from repeated fractures or bending in response to stress, since the rigidity provided by the normal osseous framework is lost.

The principal diagnostic criteria can be summarized as follows:

(*A*) *Roentgen Criteria:*

1. A localized, well demarcated area of decreased density demonstrable within a bone.
2. Limitation of the lesion, when in a long bone, to the diaphysis or metaphyseal side of the epiphyseal line.
3. Eccentric location of the lesion, with involvement of the endosteal surface of the cortex at some point.
4. Usual occurrence of a homogeneous increased density within the lesion, giving it a "smudged" or "ground glass" appearance.
5. Usual slight to moderate bone expansion, but with severe deformity in cases with extensive involvement.

6. Absence of periosteal reaction (except following a pathological fracture), penetration of the cortex, or soft-tissue invasion.
7. A zone of increased density surrounding the area of involvement, especially evident in the smaller fully developed lesions.
8. Normal density of uninvolved bone.
9. Tendency to slow extension in childhood and non-progression in adults.
10. Frequent occurrence of pathological fracture.

(*B*) *Collaborative Criteria:*

1. Characteristic occurrence in childhood or early adult life.
2. Normal blood chemistry except for occasional slight elevation of the alkaline phosphatase.
3. Absence of signs of inflammation or soft-tissue tumors in the overlying skin and subcutaneous tissues.

DIFFERENTIAL DIAGNOSIS

While the criteria listed above are usually sufficient to permit a radiologic diagnosis of fibrous dysplasia, other bone lesions must frequently be considered in the differential diagnosis:

(*a*) *Non-osteogenic fibroma* is identical with a smaller lesion of fibrous dysplasia except for the intrinsic "smudged" appearance produced by the metaplastic bone spicules in the latter.

(*b*) *Solitary bone cysts* are characteristically located in the metaphyseal medulla, usually abutting on the cartilage plate of the epiphysis. The proximal end of the humerus, femur, or tibia is most frequently affected. The cysts produce bone rarefaction but no significant condensation of the surrounding bone. When they increase in size, they may expand the shaft and cause a thinning of the cortex. The intrinsic calcification accompanying fibrous dysplasia is absent.

(*c*) *Enchondroma* occurs most commonly in the small bones of the hands and feet, an uncommon location for fibrous dysplasia. The shafts of the long bones are rarely involved. A few small points or blotches of calcification or ossification are sometimes present within the lesion proper (11), and help to differentiate it from fibrous dysplasia with its homogeneous increased density, though areas of calcification may be seen in some of the extensive fibrodysplastic lesions. Enchondroma tends to be centrally located in the medulla in contrast to the eccentric location of fibrous dysplasia.

(*d*) *Giant-cell tumor* can usually be differentiated by the following features: usual initial location in the epiphysis of a long bone; later age group (twenty to forty years); occurrence as a solitary tumor; greater expansion of the cortex; absence of calcification within the lesion proper; and response to irradiation.

(*e*) *Eosinophilic granuloma, Letterer-Siwe's disease, and Hand-Schüller-Christian disease* cause osteolytic lesions which are rarely demarcated by a sclerotic border (less than 10 per cent). The lesions may occasionally extend to involve the cortex and show periosteal reaction, but there is no intrinsic increased density ("smudge"). The bones of the leg, which are common sites of fibrous dysplasia, are usually spared by eosinophilic granuloma. This group of diseases occurs more frequently in males (7:1). Obviously, the clinical features are of great importance whenever the reticuloendothelioses are considered.

(*f*) *Neurofibromatosis* with bone involvement may closely simulate fibrous dysplasia, but the following points should be sufficient for differentiation: development of the osseous defect by erosion of the fibrous nodule from the periosteal surface into or through the cortex; the presence of the typical soft-tissue tumors in the skin or subcutaneous tissues; absence of calcification within the lesion; tendency to general distribution; and occasional involvement of the epiphyseal cartilage.

(*g*) *Chronic bone abscess* (Brodie's) may resemble the smaller lesions of fibrous dysplasia but can usually be differentiated by the absence of trabeculation within the lesion; little, if any, expansion of the cor-

tex; occasional presence of a sequestrum; zone of reaction or sclerosis around the lesion; occasional occurrence in the epiphysis; and usual medullary location.

(*h*) The following are sufficiently rare or so unlikely to cause confusion that they deserve only passing mention in the differential diagnosis: angioma, epithelial inclusion cyst, adamantinoma, benign chondroblastoma, tuberous sclerosis, cystic tuberculosis, gumma, epidermoid, osteoid osteoma, lymphoblastoma, solitary myeloma, dyschondroplasia (Ollier's disease), and pyogenic or fungus infection of bone. Finally, in some cases the differential diagnosis cannot be made without biopsy and, occasionally, the diagnosis will remain in doubt even after this procedure.

PATHOLOGY

The characteristic gross and microscopic features of fibrous dysplasia as described by Lichtenstein and Jaffe (15) and by Schlumberger (20) were observed in all of the cases in this series. On gross examination the normal bone was replaced by fibrous tissue which showed the typical firm, rubbery consistency. On section, a characteristic gritty sensation resulting from the presence of minute spicules of metaplastic bone was noted. Some lesions contained tiny fluid-filled cysts, but in only one was there a true cyst of any considerable size. The cortex showed variable degrees of thinning but never to the point of complete disappearance. The pathological report in Case 3 described the presence of great amounts of whorled, interlacing fascicles of fibrous tissue which presented a benign appearance. Evenly distributed through this fibrous matrix were many histiocytes whose cytoplasm was replaced by a substance having the appearance of fat. The cells were greatly enlarged, the cell membrane was distended and the cytoplasm traversed by many fine fibrillae, giving the cytoplasm a lacy appearance. The nucleoli were eccentric. The diagnosis was: bone, fibula, fibrous dysplasia (Capt. E. F. Alston). This diagnosis was concurred in by the Army Institute of Pathology. All cases showed a similar basic appearance but with minor variations in the degree of cellularity and the amount of metaplastic bone spicule formation. A tendency to whorl formation was commonly noted. A few small giant cells were seen in some sections. Sections from three cases showed small areas containing a few foam cells. None showed areas of cartilage formation. The latter observation is of interest, since the presence of small areas of cartilage has been reported by some authors to be of not infrequent occurrence, though Schlumberger (20) found it only in those cases in which a pathological fracture had occurred.

CASE REPORT

CASE 1: A white male was first hospitalized in July 1934, at the age of six years, because of pain in the lower half of the left leg for six months and slight swelling of the same region for three months. He had fallen and sustained an injury to the leg a few months prior to onset of the pain. Roentgen examination at the first hospitalization revealed "several cystic areas in the left tibia" (Fig. 1A). A diagnosis was made of fibrocystic disease of the bone, and surgical treatment was instituted, with unroofing of the lesions, curettage (no record is available of the histologic findings at that time), and application of phenol and alcohol to the involved areas. The wound healed promptly. Follow-up examinations indicated that the lesion was still progressing, and roentgen irradiation of the leg was started. The cervical region was also irradiated. Irradiation was given at intervals of three weeks for approximately two years (dosage unknown). The swelling remained, but there were no other symptoms until 1942, when the leg began to enlarge considerably just below the tibial tubercle and on the medial aspect of its mid portion. The patient experienced some pain, and there continued to be slow, progressive enlargement until admission to Brooke General Hospital in December 1946.

Physical examination revealed a fusiform enlargement of the upper and mid portion of the leg with the intervening part less enlarged. Roentgen examination showed anterior and medial bowing of the tibia with irregular expansion. There were numerous areas of decreased density in the cortex and medulla with increased density of the adjacent cortex and zones of increased density surrounding the individual "cystic" areas (Fig. 1E). A few small lesions distal to the principal area of involvement showed soft-tissue density with no surrounding zone of increased density. The roentgenologic diagnosis was fibrous dysplasia. Skeletal survey showed no other lesions.

Laboratory findings were as follows: blood count

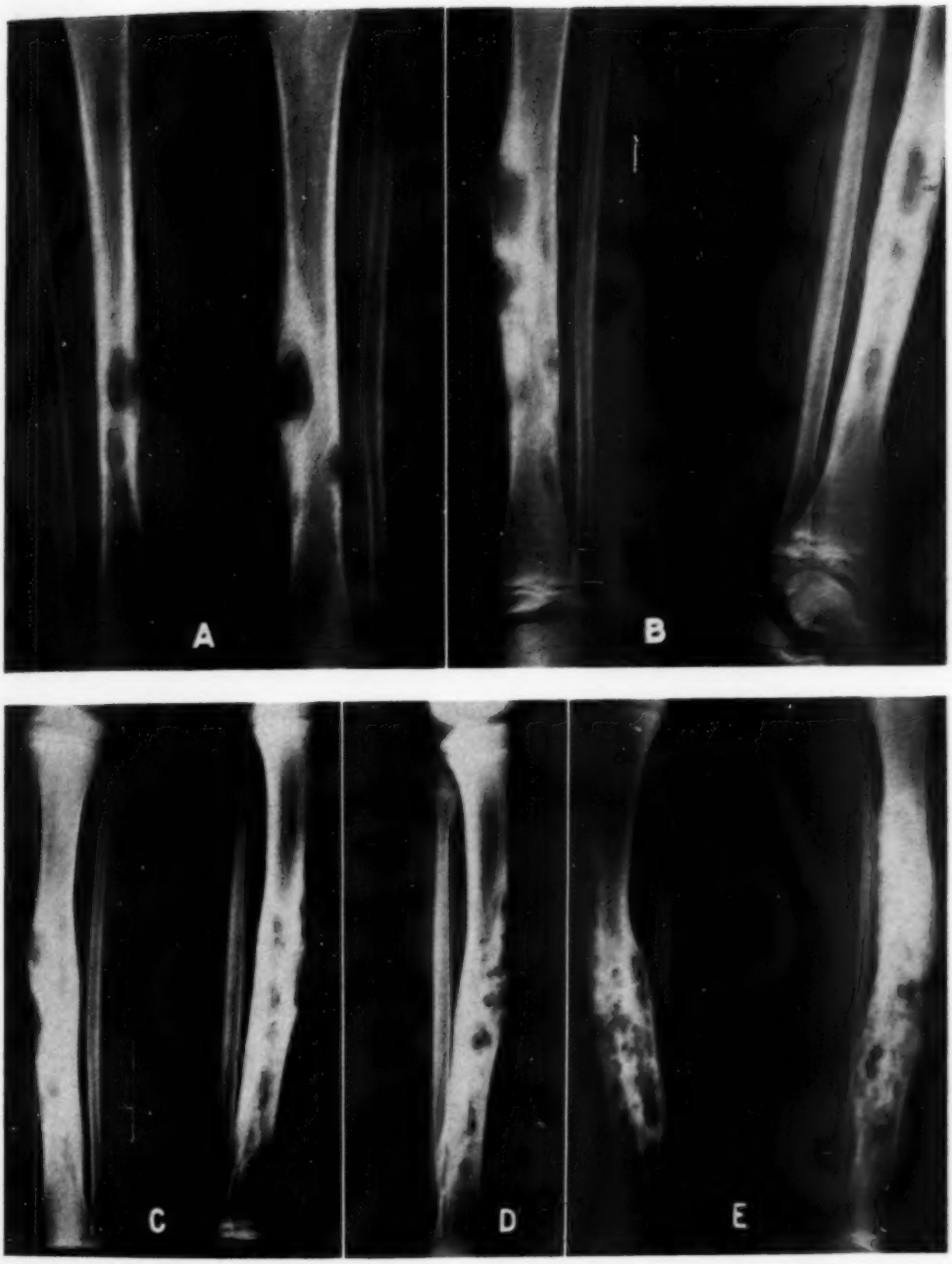

Fig. 1. Case 1. **A. Lesion in tibia at time of original admission, at six years of age.** Note cyst-like areas in bone with poorly defined margins, eccentric location with cortical encroachment but no penetration, and beginning expansion. B. At age of seven years. Note progression, with new lesions in spite of surgery and roentgen therapy; larger lesions show "smudge."
C. Age nine years: lesion progressing with increased deformity; note dense bone surrounding "cystic" areas. D. Age twelve years: few new areas of involvement in distal diaphysis showing no dense border or "smudge", while adjacent older lesion shows both features; periosteum over proximal lesions thin but intact. E. Age eighteen years: lesion more extensive, with increased deformity and expansion.

TABLE I: SUMMARY OF CLINICAL AND RADIOLOGIC FINDINGS IN CASES 2–9

Case No., Site of Lesion, and Age of Patient	History	Local Findings	Expansion	Trabeculation	Homogeneous Density "Smudge"	Size	Pathological Fracture	Remarks
2: Proximal tibia, 19 yr.	Injury in "jeep" accident. Roentgen examination of contused knee revealed lesion in tibia as incidental finding. No previous symptoms	None	No	Yes	No	1.5 × 2.5 cm.	No	Evacuated from overseas with diagnosis of "bone cyst"
3: Proximal fibula, 20 yr.	No symptoms until pathological fracture incurred by jumping into ditch	Slight persistent swelling	Yes	Yes	Yes	2.5 × 4 cm.	Yes	Evacuated from overseas with diagnosis of "cyst" of fibula. See Fig. 3
4: Proximal tibia, 19 yr.	While piling blankets patient felt "sudden cracking" in lower leg, followed by persistent local swelling. Six months later, pathological fracture necessitating hospitalization	Moderate swelling	Yes	Yes	Yes	4 × 5.5 cm.	Yes	Skeletal survey showed no other lesions. See Fig. 4
5: Proximal tibia, 18 yr.	Pain and swelling of both knees developed overseas. Roentgen examination revealed lesion in tibia. No history of injury	None	Yes	Yes	Slt.	1 × 3 cm.	No	See Fig. 5
6: Distal femur, 18 yr.	Intermittent swelling and moderate pain in left knee for 10 months. No preceding injury	Slight periarticular edema	Slt.	Yes	No	2 × 3 cm.	No	Evacuated from overseas with diagnosis of giant-cell tumor. See Fig. 6
7: Distal tibia, 18 yr.	Two years before admission patient received a "bone bruise" of right leg during a football game. Tired, aching feeling in leg for 5 months	None	No	Yes	Yes	2.5 × 3 cm.	No	Skeletal survey showed no other lesions. See Fig. 7. Fig. 8 shows microscopic appearance
8: Neck and proximal shaft of femur, 24 yr.	Patient struck hip against seat of plane 2 years before and was treated for "sprain." Again "bruised" hip 8 months before admission; this was followed by persistent dull ache	None	Slt.	No	...	3 × 6 cm.	Yes	Diagnosis was confirmed by operation following transfer to another Army General Hospital
9: Proximal femur, 19 yr.	Fracture of upper femur in 1943. Refracture at same site in 1944; metallic plate applied. Moderate activity produced pain at old fracture site and patient was evacuated from overseas with diagnosis of giant-cell tumor	1.5" shortening of leg	Yes	Yes	No	3 × 6 cm.	Yes	At operation, one fairly large, fluid-filled cyst was found; the remainder of the lesion consisted of typical fibrous dysplastic tissue

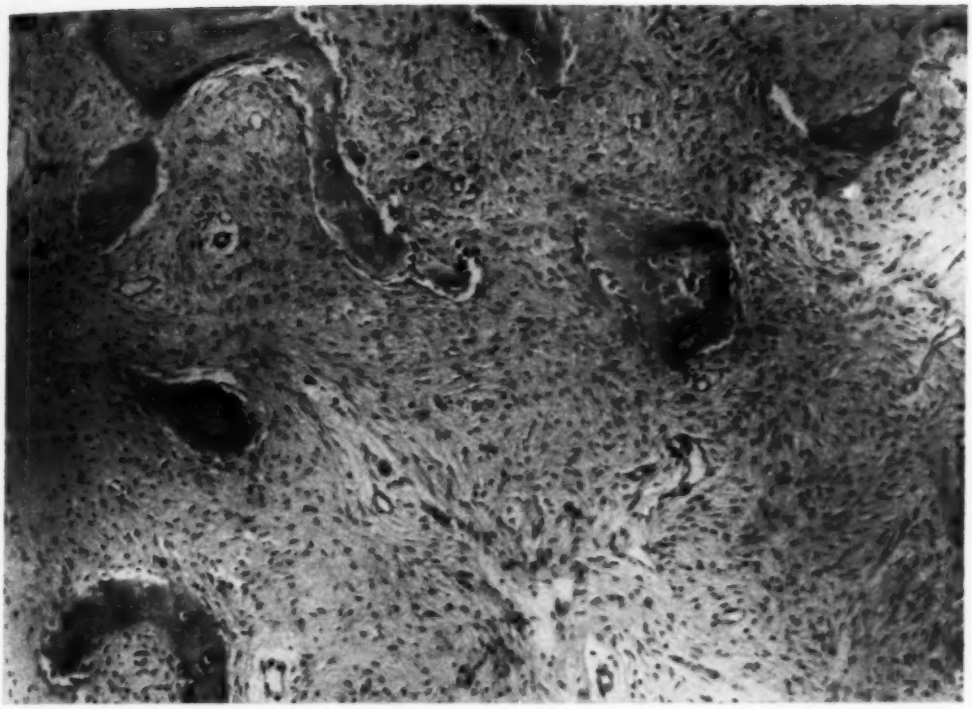

Fig. 2. Case 1. Section from lesion in tibia showing typical fibrous tissue with minute bone spicules which give the lesion the "ground-glass" or "smudged" appearance. × *c.* 210.

and urinalysis within normal limits; serology negative; blood calcium 9.6 mg. per cent, phosphorus 4.5 mg. per cent, alkaline phosphatase 2.5 Bodansky units.

In January 1947, a thorough curettage of all involved areas was performed, and the defective bone was re-enforced by multiple bone grafts. Pathological examination of the removed tissue showed cancellous bone containing portions of yellow marrow replaced in some areas by irregular masses of grayish-white fibrocartilage-like tissue. Microscopic study (Fig. 2) disclosed a relatively loose cellular fibrous tissue. The cells had a characteristic spindle shape, varied slightly in size and form, and exhibited oval to spindle-shaped nuclei with faint condensations of chromatin and occasional nucleoli. Scattered throughout this fibrous tissue were numerous spicules of young bone showing prominent osteocytes and often surrounded by osteoblasts. The diagnosis was fibrous dysplasia of bone (Maj. Lester S. King). The diagnosis was concurred in by the Army Institute of Pathology.

Comment: This case presented an opportunity to study the development of fibrous dysplasia during the period of skeletal growth. At the first examination (Fig. 1A) there was no evidence of homogeneous increased density—"smudge"—but this appearance subsequently developed. The osseous proliferation on the medial surface to compensate for the weakened bone (Wolff's law) was also demonstrated. In the fully developed stage there were small, presumably young, lesions in the distal diaphysis which did not yet have the surrounding zone of increased density, suggesting that this feature is a later manifestation. The ineffectiveness of treatment in this case was demonstrated by progression in spite of surgery and irradiation.

The remaining cases are summarized in Table I.

DISCUSSION

The exact nature of the disorder underlying fibrous dysplasia remains unknown. Numerous theories of pathogenesis have been advanced. Lichtenstein and Jaffe (15) suggested a congenital defect of devel-

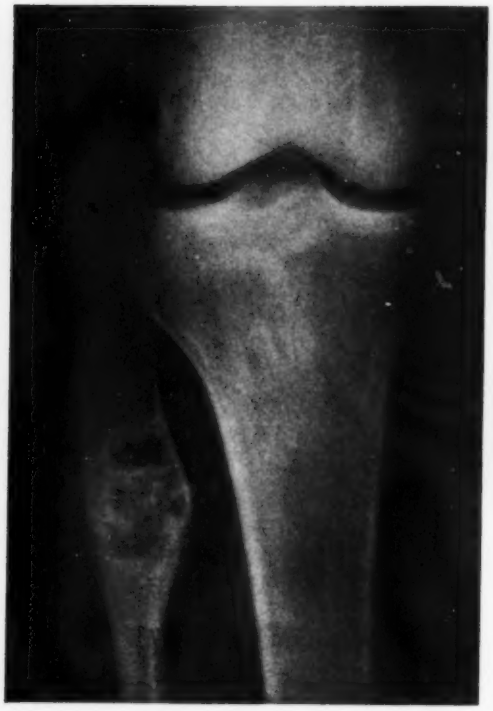

Fig. 3. Case 3. Fibrous dysplasia in fibula. Note expansion, coarse columns of bone resembling trabeculation, and pathological fracture.

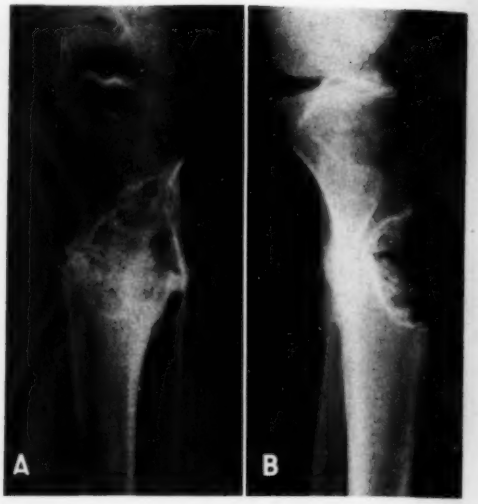

Fig. 4. Case 4. Lesion in tibia. A. Note distinct border of increased density and "smudged" appearance in lesion. A pathological fracture has occurred and callus is present. B. Note eccentric location of lesion.

opment. Thannhauser (22) considers the condition to be related to neurofibromatosis. Schlumberger (20) saw the bone lesions as a possible result of disturbance of the normal reparative processes following bone injury. Snapper (21) regards the process as a lipoid granuloma and stresses the presence of xanthoma cells in fresh lesions. Hemorrhage into bone has also been postulated as a cause.

The relation of trauma to the discovery of the lesion is obviously important, but the etiological relationship remains very questionable. It would seem improbable that trauma is a fundamental factor in view of the rarity of development of the disease at the site of a bone injury where there has been roentgenographically demonstrable bone damage. The development of new lesions in Case 1, after several years, in segments of the diaphysis nearer the epiphyseal line than the original site also argues against a traumatic etiology. The tendency to attribute any abnormality to a previous injury is well recognized, and practically everyone has received sufficient traumata to be able to remember at least one for any part of the body that may be affected.

The absence of any etiological relationship between fibrous dysplasia and hyperparathyroidism has been well established. The recognition of the fundamental differences between these two conditions should prevent future needless exploration of the parathyroid glands.

Cases of polyostotic fibrous dysplasia with extraskeletal involvement have been studied but are not included in this series. Excellent discussions of this condition are given by Dockerty, Ghormley, Kennedy and Pugh (7), Albright (3), Jaffe (12), and others. Its relation to monostotic involvement is the subject of some difference of opinion.

The relation of fibrous dysplasia to bone cysts is of some importance. Hodges, Phemister, and Brunschwig (9) consider that the fibrous tissue found in lesions of "osteitis fibrosa cystica localisata" develops following hemorrhage into true cysts.

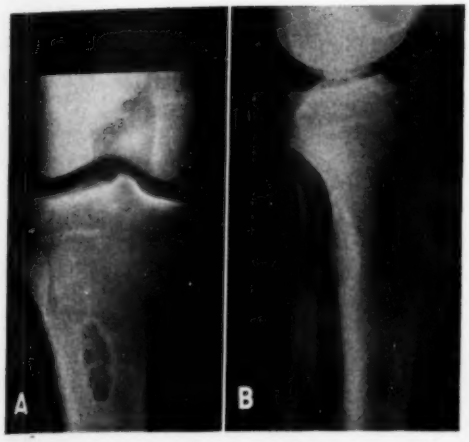

Fig. 5. Case 5. A. Small lesion of fibrous dysplasia in tibia resembling cyst. Border of increased density adds to sharp demarcation. B. Note eccentric location, mainly involving the cortex. The periosteum and thin layer of cortical bone adjacent to it are intact.

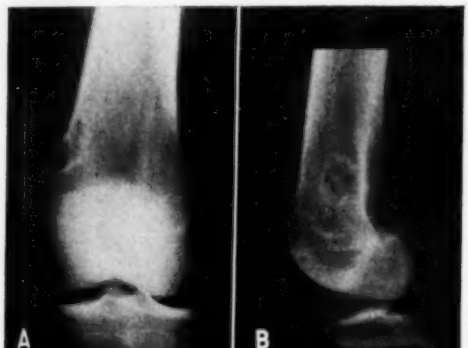

Fig. 6. Case 6. A. Solitary lesion in femur. Coarse columns of bone bordering the areas of fibrous tissue give a trabeculated appearance. B. Lateral view suggests central location but Fig. 6A shows typical eccentric location. The border of the lesion is narrow but fairly dense.

Lichtenstein and Jaffe (15), on the other hand, are of the opinion that the characteristic fibrous tissue which fills these cyst-like lesions is the primary constituent, while the small true cysts occasionally found at operation represent focal degeneration in this fibrous tissue. In this series of cases there were only two in which true cyst development could be demonstrated, and in these the fibrous tissue constituted the major portion of the lesion.

The location of the lesions is fairly characteristic. In this group there were 3 in the femur (1 in the proximal metaphysis, 1 in the proximal diaphysis, and 1 in the distal diaphysis), 5 in the tibia (4 in the proximal metaphysis or diaphysis and 1 in the distal diaphysis), and 1 in the proximal diaphysis of the fibula. The unproved cases showed lesions in the femur in 3 instances, in the tibia in 6, in the fibula in 2, in the humerus in 1, and in the ischium in 1.

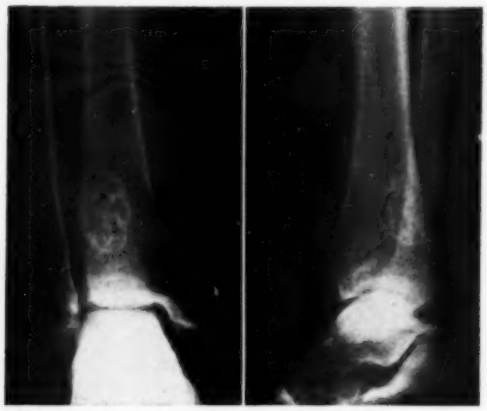

Fig. 7. Case 7. Sharply demarcated lesion in tibia. Biopsy showed fibrous tissue with minute bone spicules (Fig. 8).

The reliability of the roentgenologic diagnosis of fibrous dysplasia can be estimated from the following analysis of this series:

25 cases roentgenologically diagnosed fibrous dysplasia
13 cases not biopsied
12 cases biopsied
9 cases confirmed
3 cases in error

During this period there has been no instance of error in roentgenologic diagnosis of cases which have proved to be fibrous dysplasia on histologic examination. This analysis of proved cases makes it probable that the error will not exceed 25 per cent.

The cases which were erroneously diagnosed as fibrous dysplasia proved, on biopsy, to be eosinophilic granuloma (1 case), giant-cell tumor (1 case), and unicameral bone cyst (1 case). These lesions

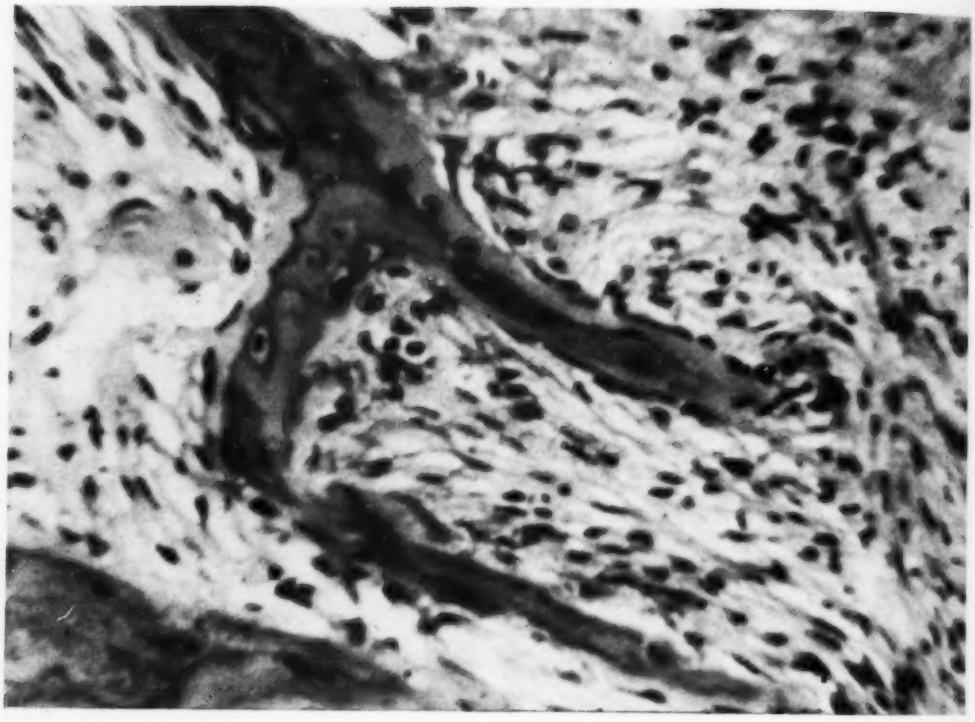

Fig. 8. Case 7. Section from lesion shown in Fig. 7. Minute bone spicules are scattered throughout the fibrous tissue. × *c.* 525.

did not show the typical roentgenographic appearance of fibrous dysplasia.

The lesion was progressive in Case 1, but no other case in this series showed any change in size or appearance during the period of observation except as a result of fracture or surgery. This suggests that the progressive tendency occurs only during the period of active skeletal growth.

The prognosis is good in that the condition tends to be self-limited. Most authors state that malignant degeneration is not known to occur, but Coley and Stewart (6) report 2 cases of polyostotic fibrous dysplasia in adults with subsequent development of sarcoma, and Camp (5) reports 1 such case. Occasional spontaneous healing has been reported, but no evidence of such has been seen in this series.

Treatment is indicated in those cases which are definitely symptomatic and in cases where the lesion is located in a position where pathological fracture is probable or has repeatedly occurred. Simple excision or curettage and bone graft are usually adequate in the adult. Recurrence was noted in only one case in this series (Case 1) and that was during childhood. Irradiation is generally considered not to be effective in controlling the lesion. This was true in the one case in this series (Case 1) which was irradiated.

SUMMARY AND CONCLUSIONS

The clinical, roentgenologic, and pathologic aspects of monostotic fibrous dysplasia are presented, with specific findings in 9 cases which have been confirmed by operation and histologic study at Brooke General Hospital during the two-year period 1946–47. Brief comment is also made regarding 13 unconfirmed cases with a characteristic roentgen picture seen at that hospital during the same period.

The roentgenographic appearance of the majority of lesions of fibrous dysplasia is

characteristic. The diagnostic features most frequently observed include: a sharply demarcated area of decreased density resembling a cyst; a homogeneous increase in density within the lesion, giving a "smudged" appearance; a zone of increased density surrounding the smaller lesions; and eccentric location in the diaphysis or metaphysis of a long bone.

Atypical lesions cannot be unequivocally identified by the roentgen and clinical findings and must be diagnosed by biopsy.

The lesions of fibrous dysplasia tend to be progressive during the period of active skeletal growth and stationary during adult life.

Conditions to be differentiated from fibrous dysplasia are non-osteogenic fibroma; solitary bone cyst; enchondroma; giant-cell tumor; eosinophilc granuloma; Letterer-Siwe's disease, and Hand-Schüller Christian disease; neurofibromatosis, and chronic bone abscess (Brodie's abscess).

NOTE: Acknowledgement is gratefully made of the advice and assistance of Major A. J. Ackerman in collecting the cases and preparing the manuscript; and of the assistance of Col. Elbert DeCoursey and his laboratory staff in the pathological studies.

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(For Spanish Summary see following page)

SUMARIO

Displasia Fibrosa del Hueso (Monosteótica)

Al exponer los aspectos clínico, roentgenológico y patológico de la displasia fibrosa monosteótica, preséntanse los hallazgos específicos en 9 casos confirmados por la operación y el estudio histológico. También se ofrecen breves comentarios acerca de otros 13 casos no confirmados, pero con típico cuadro radiológico.

El aspecto radiográfico de la mayoría de las lesiones de la displasia fibrosa es típico. Los rasgos diacríticos observados más a menudo comprenden: una zona netamente demarcada de menor densidad que semeja un quiste; aumento homogéneo de la densidad en el interior de la lesión, creando un aspecto "tiznado"; una zona de mayor densidad que circunda las lesiones más pequeñas; y localización excéntrica en la diáfisis o metáfisis de un hueso largo. Las lesiones atípicas no pueden ser inequivocablemente identificadas por los hallazgos radiográficos y clínicos, teniendo que ser diagnosticadas por la biopsia.

Las lesiones de la displasia fibrosa suelen ser progresivas durante el período de desarrollo activo del esqueleto y estacionarias durante la vida adulta.

Estados que hay que diferenciar de la displasia fibrosa son: fibroma anosteógeno; quiste óseo solitario; encondroma; tumor gigantocelular, granuloma eosinofílico, enfermedad de Letterer-Siwe y enfermedad de Hand-Schüller-Christian; neurofibromatosis; absceso óseo crónico (absceso de Brodie).

Parotid Tumors

A Review of Ninety-Three Cases[1]

MARCUS J. SMITH, M.D., and K. WILHELM STENSTROM, Ph.D.

THE TREATMENT of a parotid tumor is primarily a surgical problem. Radiation therapy may, however, be required either in combination with surgery or because in a given case it is the only suitable method. In order to obtain some information concerning the results of such therapy, the records of all the patients referred to the radiation therapy section at the University of Minnesota Hospitals between 1927 and 1947 for treatment of parotid tumors were reviewed. A brief discussion of the disease and the 93 cases constituting this series is here presented.

Any attempt to evaluate the results of treatment of parotid tumors is rendered difficult by the pathology, pathogenesis, and clinical course of the mixed tumors which constitute a large percentage of parotid neoplasms. These tumors present a most bizarre and variable pathologic picture, and a great number of histologic classifications have appeared in the literature. We have abided by the decision of the Department of Pathology of the University of Minnesota Hospitals, and classified parotid tumors in two main groups: mixed tumors and carcinomas (adenocarcinoma, cylindroma, undifferentiated carcinoma, etc.).

Briefly, two theories of origin of mixed tumors are considered at the present time (37): the single-tissue origin, from epithelium of salivary or mucous glands or from detached salivary gland anlage, and the dual tissue origin, from branchial cleft inclusions or embryonal non-branchial anlage (ectoderm and mesenchyme). Probably the former theory is now the most acceptable, particularly since the demonstration by Fry (14) that cartilage found in mixed tumors is really simulated cartilage, and epithelial in origin. This was also demonstrated by Allen (2). This is of importance, from our point of view, only in so far as radiosensitivity is concerned. Differences in pathogenesis may be responsible for variations in radiosensitivity. The more embryonal the tissue, the more sensitive to radiation we may expect it to be.

No reports of parotid tumors have been found in which any etiologic significance was attributed to trauma, although Fraser (13) claimed to have produced such tumors in animals by traumatizing the ductal epithelium. Infections and calculi do not seem to play an important role in the development of these tumors.

Mixed tumors contain epithelium, cartilage, lymphoid tissue, and connective tissue, this last showing evidence of mucin production (5, 8). The nature of these tumors, *i.e.*, whether malignant or benign, has been a matter of controversy. Ahlbom (1) recognized benign and malignant subdivisions, based on microscopic appearance. Some authors have been of the opinion that mixed tumors are benign (6, 15, 30, 34). Merritt (27) referred to them as "mildly malignant.' Fry (14) could find no definite dividing line between innocent and malignant, and Dixon and Benson (12) stated that "most pathologists agree that mixed tumors of the parotid gland are almost invariably malignant." Levin (19) believed that the mixed tumor represents a malignant transformation of a teratoma, while Krompecher (17) felt that all mixed tumors were basal-cell carcinomas. McFarland (26) based his opinion on Ewing's six criteria of malignancy:

(1) Infiltrative growth: Mixed tumors do infiltrate if their capsules are opened.

[1] From the Department of Radiology and Physical Therapy of the University of Minnesota and the University Hospitals, Minneapolis, Minn. Accepted for publication in March 1948.

(2) Local tissue destruction: Rarely associated with mixed tumors.
(3) Recurrence after removal: A chief characteristic of mixed tumors.
(4) Metastases: Rarely associated with mixed tumors. However, metastases have occasionally been reported (20, 31). Mulligan (28) reviewed 22 such cases and added 20 new ones. He concluded that metastasis occurs more often than is generally assumed.
(5) Local interference with function: Mixed tumors occasionally cause restricted jaw motion, deafness, seventh nerve palsy, rarely fifth nerve pain, and more rarely still, cystic dilatation of the parotid gland.
(6) General toxic action of absorbed tumor products: Not found with mixed tumors.

In view of these facts, McFarland (24) concluded that "mixed tumors do not, therefore, become malignant; rather they are malignant, though this is true in varying degrees in different cases."

Adenocarcinoma, cylindroma, and squamous-cell carcinoma arise from glandular, basal-cell (32), and squamous-cell tissue. The carcinomas are difficult to influence by radiation and the results of treatment have, as a rule, been unsatisfactory.

The first successful treatment by radiation of a malignant parotid tumor was reported in 1909, by Wickham and Degrais (38), who used surface radium. Since then numerous case studies have appeared in the literature. Particularly notable are the reports of McFarland (24–26) and Ahlbom (1). For a more complete review of the historical aspects of parotid tumors, the reader is referred to the article of Utendorfer (37).

MIXED TUMORS

Our series included 58 mixed tumors. Of these, 45 were confirmed pathologically; no pathologic reports were available for the other 13. Statistics as to recurrence will include only the proved cases. The pathologic findings are based on study of the surgical specimens; biopsies were not taken. This is in conformance with the accepted belief that biopsy causes rupture of the tumor capsule and danger of dissemination (24, 37).

Among 65,351 hospital admissions, T. M. Martin (23) found 34 mixed parotid tumors, an incidence of 0.05 per cent. These tumors may occur at any age and have been reported (16) as early in life as seven months and as late as eighty years. The most frequent age of appearance is in the third decade, with about equal division among the sexes, and without evidence of preference as to side of involvement (16, 19, 22, 37).

The 58 mixed tumors reported here represent 63 per cent of our series of parotid tumors. The age range was from thirteen to seventy-two years, the average being 39.7 years at the time of treatment. Nineteen patients were males (33 per cent). In 26 cases the right side was involved (45 per cent). All patients were of the white race, but because of the small Negro population in Minnesota this is not significant.

Characteristic clinical findings were a firm nodule in the parotid region, progressing very slowly in size over a period of many years. It was usually painless, although mild aching or pain was occasionally present. The non-tender mass was attached to the underlying gland, but was usually not adherent to the skin. Occasional manifestations were involvement of the seventh nerve by large tumors and recent increase in size before treatment was requested. The tumors ranged in size from 1 × 1.5 cm. to 10 × 15 cm., the average diameter being 2.6 cm. in 44 cases in which the original size was recorded. The duration of the tumor before treatment at the University Hospitals ranged from three months to twenty-five years and averaged 5.5 years. Stein and Geschickter (34) gave the average duration as four years and Hawk and Shepherd (16) as eight years. Ten patients had received surgical treatment elsewhere two to twenty

years before being treated at the University Hospitals.

Combinations of surgery, x-rays, and radium were used in the treatment of mixed tumors (Table I). Some cases, not included in this report, were treated by surgery alone. The surgical procedure consisted of enucleation or curettement. Total parotidectomy, a relatively recent surgical approach (3, 4, 36), was not used. The x-ray therapy factors in general were 200 or 220 kv., 15 or 30 ma., 0.5 mm. Cu filter, 60 cm. distance. The dose was 1,200 to 1,500 r/air to each of three fields, over the parotid region: anterior oblique, posterior oblique, and lateral. Field sizes averaged about 8 × 10 cm., and the treatment time per case ranged from two to four weeks. Radium therapy was given in the form of radon seeds implanted into the tumor bed; 1 to 1.5 mc. gold (0.3 mm.) implants were used, and dosages ranged from 700 to 2,000 mc. hr., depending on the size and distribution of the lesion. All therapy was postoperative except for recurrences, which were usually treated with radiation alone.

It is generally agreed that five-year survival rates are meaningless in assessing results of treatment for mixed tumors. Most observers use recurrence rate as the yardstick and agree that these tumors may recur many years after treatment.

Table I shows the results in our series of patients treated between 1927 and 1937, with a ten- to twenty-year follow-up. Thirty-three cases of the entire group of 58 mixed tumors were first treated during that period.

The 7 tumors that recurred were all retreated one, one, two, four, four, five, and eleven years after the original therapy. Two of these recurred again five and twelve years after original therapy and were again retreated. Only one tumor recurred a third time and was retreated nine years after the first treatment. Of the 7 patients with recurrences, 5 are well without further recurrence twelve, ten, nine, eight, and four years after the final treatment.

TABLE I: RESULTS OF TREATMENT OF MIXED TUMORS, 1927–37

Type of Treatment	Cases	Followed Less Than 10 Years	Followed More Than 10 Years	Recurrences of Cases Followed More Than 10 Years
Surgery and x-ray	18	5	13	4
Surgery, x-ray, and radium	12	1	11	2
Surgery and radium	2	1	1	0
X-ray alone	1	0	1	1
TOTAL	33	7	26	7 (30%)

The percentage of recurrence after surgical treatment alone has been reported (6, 26, 30, 34, 35) as varying between 15 and 100 per cent. Ahlbom's (1) recurrence rate for 120 patients is considerably lower. By using preoperative roentgen irradiation or teleradium and postoperative interstitial radium therapy, he reduced the five-year recurrence rate to 6 per cent. This is probably the lowest figure reported for a good-sized series. Older reports in the literature reject irradiation as valueless (6, 11, 16, 23), while recent papers tend to favor it in combination with surgery as the preferred treatment, particularly postoperative x-ray therapy (15, 19, 27, 29). Perhaps this is because of the improvement in irradiation technics during the past twenty years.

That statistics concerning recurrence rates are open to question was well demonstrated by McFarland (26). He pointed out that his own rate of 25 per cent included cases lost to follow-up and cases observed less than five years. When he excluded these cases, his recurrence rate (surgery alone) rose to 62 per cent!

McFarland (24) also pointed out that small tumors were more apt to recur following removal than large tumors, probably because of multicentric origin and eventual fusion of small lobules into one large encapsulated mass. Therefore, he deplored haste in surgery and preferred waiting until the tumor enlarged. Our own observations did not confirm this finding, for recurrences were found in tumors of all sizes—from 1 to 9 cm. in diameter.

TABLE II: TWENTY-SIX CASES OF PROVED CARCINOMA OF THE PAROTID GLAND

Year*	No. of Cases	Years of Survival 1	2	3	4	5	6	7	8	9	10	Living	
1931	2	2	1	1	0	0	0	0	0	0	0	0	
1932	2	2	2	1	1	1	1	1	1	1	1	1	June 1946
1933	1	1	1	0	0	0	0	0	0	0	0	0	
1934	3	1	0	0	0	0	0	0	0	0	0	0	
1935	2	1	1	1	1	1	1	1	1	1	0	?	Alive July 1944
1936	1	1	1	1	0	0	0	0	0	0	0	0	
1938	3	2	2	2	1	1	1	0	0	0		0	
1940	1	1	1	1	1	1	1	1				1	May 1947
1943	1	1	1	1	1							1	February 1947
1944	3	3	3	2								2	April 1947, January 1948
1945	2	2	2									2	October 1947 (both)
1946	5	4										4	June, September, October 1947 (2)
Cases	26	26	21	19	16	15	15	15	14	11	11		
Survival	..	21	15	10	5	4	4	3	2	2	1		
Per cent	..	81	72	52	31	27							

* No cases reported in 1937, 1939, 1941, 1942.

Treatment was followed by undesirable complications in 14 of our cases. In 5 there was transient seventh nerve palsy and in 2 permanent palsy postoperatively. Four patients had skin changes over the areas of irradiation, consisting of skin atrophy and telangiectasia, and 2 patients had induration, though not of severe grade. In 1 patient, exposed to multiple episodes of surgery, radium, and roentgen therapy severe ulceration and bleeding developed necessitating prolonged hospitalization and skin grafting. There were no instances of salivary fistula.

Deaths were attributable in 3 cases to causes other than parotid mixed tumor—tuberculosis, carcinoma of the stomach, and cerebral thrombosis. The cause of death in one case is unknown. There were no proved metastases in our group.

CARCINOMA

Thirty-five cases of carcinoma of the parotid gland were observed. The pathologic specimens were not available for review in 9 instances. In these 9 cases the diagnosis had been made originally from the clinical features and had never been confirmed by biopsy. In this group, the disease was far advanced at the time of first observation and the diagnoses were based primarily on the site of the primary lesion and the symptoms and physical findings, including lymph node metastases. Of the total group, 26 were histologically malignant, ranging from cylindroma to frank carcinoma; there were 2 proved squamous-cell carcinomas originating in the parotid gland. Only the 26 cases proved by biopsy, examination of the surgical specimen, or of an involved lymph node, are included in determining the end-results (Table II).

The average age of the patients with carcinoma was 63.3 years (range was from thirty-seven to eighty-three years). Fourteen patients were males. All were white.

Clinically, these cases were characterized by tender, hard masses in the parotid region which enlarged rapidly, showing marked local invasive tendencies. Usually the tumors were adherent to the skin and underlying tissues; often the masses were ulcerated and fungating. Severe pain was common; seventh nerve involvement and fifth nerve neuralgia were not unusual. Interference with jaw function was occasionally seen. Metastases to cervical nodes were present on admission in 12 cases (including 3 in the clinical group); pulmonary metastases were present in 2 cases and osteoblastic metastases in the pelvis and spine were present in 2 cases (not verified postmortem). There were some cases in which the presenting clinical picture resembled that of mixed tumors, and microscopic sections had to be studied in order to make the diagnosis.

One of the striking clinical features was the long duration of the parotid tumor before it had begun to enlarge rapidly. In 13 cases there was a history of ten or more years. Three tumors had been present thirty years or longer, one for thirty-eight years. No doubt these had been regarded as mixed tumors and left untreated (by choice or neglect) until they began to enlarge, usually a few months to a year before being referred for treatment. Six cases had received previous surgery.

Treatment was similar to that for mixed tumors, but more intensive. Surgery consisted of excision, including one total parotidectomy and two radical neck dissections. For x-ray therapy the same factors were utilized as for mixed tumors except that the doses ranged from 1,200 to 1,800 r/air and the fields were larger and included the cervical lymph channels and nodes. Radon seeds were inserted postoperatively or as an independent procedure, in doses similar to those for mixed tumors. Excision, radon insertion, and postoperative x-ray irradiation, followed by a second and third course of x-ray and interstitial radiation therapy, was the rule rather than the exception. Inoperable cases and recurrent cases were treated by irradiation alone, and fair to good palliation was obtained, judged by relief of pain, improvement of jaw function, and decrease in the size of the mass.

Results in terms of five-year survivals were poor. In the unproved group there were 8 deaths, 2 of the patients surviving five and six years before succumbing to the disease. One patient is alive two years after treatment, but not free from carcinoma. In the total group there were 18 deaths and 3 cases were untraced. Of the 26 proved cases (Table II), 11 were treated too recently for five-year follow-up. Among the 15 cases followed for five years or longer, there were 4 five-year survivals (27 per cent). One patient died of disease during the sixth year of follow-up; one is alive and probably free from cancer during the fourteenth year (a lump is present in the gum, but without increase in size for three years), and one was free from disease after nine years.

Benedict and Meigs' (6) mortality in 30 proved cases of parotid gland carcinoma was 96.7 per cent. MacFee (21) reported 3 out of 27 patients (11 per cent) surviving after five years. In a series of 20 cylindromas, Quattlebaum, Dockerty, and Mayo (32) reported 8 deaths from metastases in five years, 2 deaths after five years, and 4 inoperable recurrences. Ahlbom (1), using teleradium or x-rays preoperatively or postoperatively, or radiotherapy alone for inoperable and radiosensitive operable lesions, obtained a 25 per cent five-year survival in 82 malignant parotid gland tumors. Cade (10), using preoperative irradiation, had 5 of 14 patients alive without disease after five years.

Poor results can possibly be correlated with the failure of the patient to report for early treatment. They can be blamed partially on a widespread belief that haste in treatment of mixed tumors is not necessary. Since biopsies are taboo in mixed tumors and since it is often difficult to distinguish between a mixed tumor and carcinoma, it seems advisable to urge operative removal, subsequent radiation, and microscopic study as soon as possible after detection of the tumor in order to avoid the poor results obtained in the treatment of carcinomatous parotid tumors that have been dormant for many years. Perhaps preoperative irradiation should be added to the armamentarium. Ahlbom's results, using that method, are better than average. Should the tumor turn out to be a mixed tumor, no harm has been done, for some observers feel that preoperative irradiation simplifies surgery for mixed tumors by making the capsule firmer and easier to remove (1, 10, 34).

CONCLUSIONS AND SUMMARY

1. Ninety-three cases of parotid tumor are reviewed: 58 mixed tumors and 35 carcinomas.

2. The pathogenesis of mixed tumors is reviewed briefly.

3. Mixed tumors should not be con-

sidered unqualifiedly as benign tumors, but rather should be thought of as potentially, if not actually, malignant.

4. The high recurrence rate of mixed parotid tumors indicates that surgery and irradiation should be used in combination for treatment of these growths unless the tumor is encapsulated and a complete parotidectomy can be performed. The recurrence rate for 33 patients followed for ten years or more in the present series was 30 per cent.

5. The value of radiation therapy for recurrences of mixed tumors is emphasized by the fact that 5 of the 7 patients with recurrent tumors were at the last examination following such retreatment free from any symptoms.

6. Procrastination in treatment is not recommended, since biopsies are condemned, and differential diagnosis between mixed tumor and carcinoma often depends on the microscopic findings in the surgical specimen.

7. Even with the use of radical surgery and postoperative irradiation, the five-year survival rate in carcinoma was only 27 per cent.

8. Many carcinomas had histories of lengthy duration (up to thirty-eight years). Earlier treatment seems advisable.

9. Radiation alone is valuable for recurrent and inoperable carcinomas.

NOTE: We wish to thank Dr. Robert Hebbel for reviewing the pathologic material.

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SUMARIO

Tumores de la Parótida: Repaso de 93 Casos

La serie comunicada comprende 93 tumores de la parótida (58 mixtos y 35 carcinomas), tratados ya con la radioterapia sola o combinada con la cirugía.

Los tumores mixtos no deben considerarse incondicionalmente como benignos, sino más bien como potencial o realmente malignos. Debido a su elevado coeficiente de recurrencias, deben ser tratados, a menos que estén encapsulados y pueda ejecutarse una parotidectomía total, con una combinación de cirugía e irradiación. En esta serie, la cirugía consistió en la enucleación o el raspado, y la irradiación postoperatoria comprendió rayos X, implante de semillas de radón o ambos. Entre 26 casos comprobados y mantenidos en observación durante diez a veinte años hubo 7 recurrencias (30 por ciento) después del tratamiento primitivo. El valor de la irradiación en las lesiones recurrentes queda indicado por el hecho de que 5 de estos 7 enfermos estaban sin síntomas en el último examen, de cuatro a once años después de repetirse el tratamiento.

El tratamiento en el carcinoma fué semejante al empleado en los tumores mixtos, pero más intenso. La cirugía consistió en la excisión, incluso una parotidectomía y dos disecciones radicales del cuello. La dosis de radiación fué ligeramente mayor que en los tumores mixtos y los campos también mayores, comprendiendo los conductos y ganglios linfáticos cervicales. En 15 casos comprobados el coeficiente de sobrevivencias de cinco años fué de 27 por ciento. Uno de los 4 enfermos que vivió cinco años murió de la enfermedad en el sexto año.

No se recomienda la demora en el tratamiento de los tumores parótidos, dado que las biopsias están contraindicadas y la diferenciación entre tumor mixto y carcinoma se basa a menudo en el estudio microscópico del ejemplar extirpado. Muchos carcinomas muestran una historia larga antes de aparecer rápidamente la hiperplasia que lleva al enfermo a consultar al médico; en 13 casos de esta serie había habido un tumor diez años o más y en 3, treinta años o más.

En el carcinoma recurrente e inoperable la irradiación sola posee valor paliativo.

Cavitary Form of Pulmonary Neoplasm[1]

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A LARGE AMOUNT of literature has been accumulating in recent years on the subject of pulmonary cancer. Early diagnosis has been constantly stressed, in view of the remarkable strides in thoracic surgery and the consequently more hopeful outlook if surgery is undertaken sufficiently early.

To arrive at an early diagnosis, one of the most important steps is the roentgenologic study. Various procedures, including bronchography and body-section roentgenography, have been advocated and employed in addition to the conventional chest films. The fact remains, however, that no specific roentgen signs of pulmonary cancer exist. As far as can be determined—both from personal experience and perusal of a voluminous literature—there is no roentgenologic method by which early bronchogenic carcinoma can be reliably differentiated from pulmonary infection. Bronchoscopy with biopsy is still the only means by which a positive diagnosis can be made before metastatic lesions are discovered, unless exploratory thoracotomy is performed.

Negative bronchoscopic results, however, do not rule out the existence of pulmonary cancer, especially if the lesion is located peripherally or in one of the upper lobes. To differentiate between an infectious process and a malignant neoplasm in such cases, it may be necessary to resort to serial roentgenograms, which may mean weeks, and often months, of delay, although the finding of tumor cells in the sputum by special staining methods holds great promise as an early diagnostic aid.

The type of malignant pulmonary lesion most often confused with infection is the cavitary form of bronchogenic carcinoma. Holman and Pierson (1) point out that "carcinoma may simulate suppuration so closely that neither the clinician nor the radiologist can determine the exact nature of the disease." Others, including Kirklin and Paterson (2) and Howes and Schenk (3) refer to the same difficulty. Yet we have made considerable progress since Fishberg and Rubin (4) wrote, in 1929, that while they had seen many references in the literature to this type of neoplasm, few clinicians had recognized it during the patient's lifetime. A decade later, Hauser and Wolpaw (5) reported 15 cases of cavitary bronchogenic carcinoma, in 10, or two-thirds, of which a correct diagnosis was made. In 6 of these cases the diagnosis was established by bronchoscopy, in 3 others by biopsy and thoracotomy. In one case no diagnosis could be established by any method and it was arrived at on the basis of the clinical course. Gottlieb and Sharlin (6) on the other hand, describe 2 cases in which the history, clinical picture, and roentgen appearance all suggested neoplasm, but which proved on serial roentgenography to be lung abscesses.

The frequency with which the cavitary form of bronchogenic carcinoma occurs in autopsy material is given by Hauser and Wolpaw as varying with different observers from 12 to almost 50 per cent. Fishberg and Rubin found it in 30 per cent of their cases.

The type of tumor which, in the light of experience at this hospital, most often undergoes cavitation is the more or less circumscribed, rounded mass, that is, the peripheral type of bronchogenic carcinoma rather than the infiltrating, stenosing,

[1] From the Department of Radiology, Birmingham Veterans Administration Hospital, Van Nuys, Calif. Published with the permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the authors.

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main bronchus tumor. In the former, the blood supply to the central or deeper portions of the mass eventually becomes cut off, with resultant necrosis. This may be said to be true of all rapidly growing tumors, yet we have observed cavitation in a tumor less than 4 cm. in diameter. Furthermore, Fishberg and Rubin point out that cavitation occurs almost exclusively in primary tumors. Even large metastatic masses in the lung can be observed for months without breaking down. Hauser and Wolpaw explain the excavation as often due to aseptic necrosis, resulting from occlusion of the smaller blood vessels in and around the neoplasm by tumor thrombi. In addition, infection undoubtedly plays an important role. It would appear that compression of the smaller bronchi within the tumor takes place first, with bronchiectasia distal to the compression. This leads to accumulation of secretions, infection, and finally necrosis. It is probable that a combination of both factors, changes in the blood supply and infection, are responsible for the necrotizing process in the majority of cases.

DIAGNOSIS

There is no characteristic clinical picture by which cavitary pulmonary neoplasm—or, indeed, any form of pulmonary cancer—can be recognized. It is axiomatic in medical diagnosis that often the correct interpretation may be missed simply because the possibility has not been considered. The history, clinical picture, and, above all, the patient's age should direct attention to the possibility of a malignant lesion. Cough, hemoptysis, or blood-streaked sputum, and weight loss are almost always present. Chest pain is a common symptom, and there is often a low-grade fever. Dyspnea, somewhat out of proportion to the pulmonary changes, is seen in many cases. There may be hyperesthesia of the skin on the side of the chest where the lesion is located (4). When any combination of these symptoms is present in a patient over forty years of age, neoplasm should be considered until disproved.

Roentgenologically, the lesion often presents a rather well circumscribed, round, or ovoid appearance, suggesting an infected fluid cyst or, when small, a tuberculoma. At other times the infiltration is more diffuse, simulating pulmonary abscess or ulcerating tuberculosis. The cavity is often eccentric, and the contours of the inner wall have an irregular, ragged, or "bumpy" appearance, corresponding to the irregular tissue necrosis within the tumor. This is especially well brought out by body-section roentgenography. In the conventional chest film a large portion of the inner wall may be obscured by the fluid within the cavity. In the planigram, however, the fluid gravitates into the posterior recess of the cavity and, anterior to this, the whole circumference of the cavity wall is well demonstrated. A chest film with the Bucky diaphragm, even with the patient supine, will not accomplish the same results, because of the summation of shadows lying in the same sagittal planes.

We should like to emphasize this irregular, "bumpy" character of the cavity wall in neoplastic disease. It has been described often before (4, 5, 7–9). It is not claimed to be a pathognomonic sign of cancer; it may be found at times in other conditions, especially in tuberculosis. It should be stressed, however, that its occurrence is frequent in malignant disease, and, when recognized, it will direct early attention to the true nature of the lesion.

In 3 of the 5 cases presented here the diagnosis was suggested by the appearance of the cavity; in the fourth the diagnosis was quite obvious because of the destructive rib lesions. In one case the diagnosis was not made during the lifetime of the patient.

CASE REPORTS

CASE I (Fig. 1): A 54-year-old white male was admitted to this hospital on June 26, 1947, complaining of fatigue, chronic cough productive of a copious greenish-yellow sputum, foul breath, and a weight loss of 30 pounds within the past month. He had pneumonia in the left chest six months previously, for which he was treated at home with penicillin and sulfa drugs. He returned to work after four weeks but continued to cough, and the

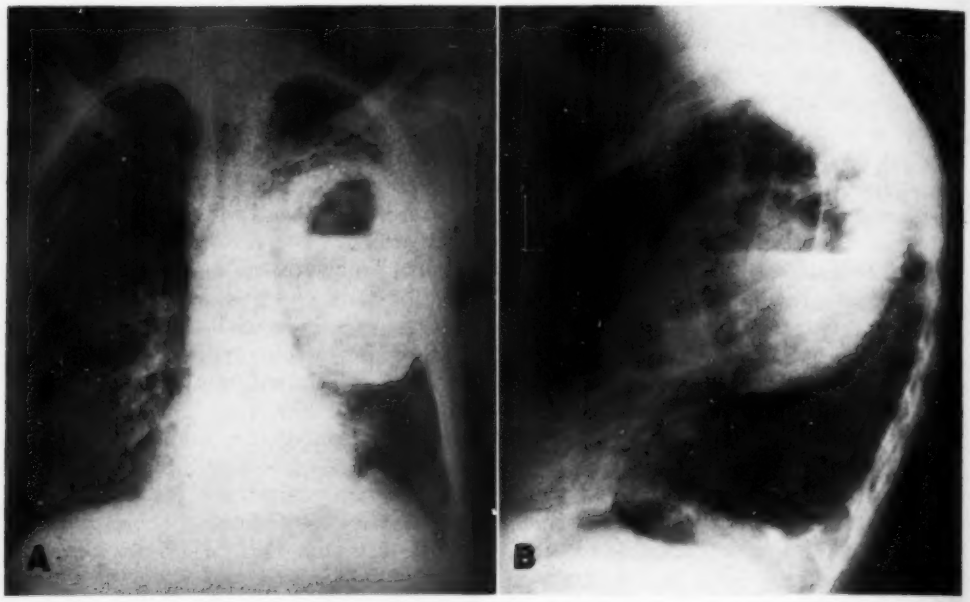

Fig. 1. Case I. A. Well circumscribed, ovoid mass in left lung with irregular, ragged cavity. B. Left lateral view, showing mass located posteriorly. C. Planigram, demonstrating irregular, bumpy contour of cavity wall.

sputum was often blood-tinged. He also complained of pain in the chest, which was aggravated by coughing.

On admission the patient appeared acutely ill and was dyspneic. The fingers were clubbed. The temperature ranged from 100 to 103° F. A chest roentgenogram on the day of admission showed a large, well circumscribed ovoid shadow in the left upper lung, adherent to the lateral chest wall. The central portion of the mass was occupied by a large cavity with ragged, irregular inner contours. Sputum examination showed many polymorphonuclear leukocytes and clumps of bacteria, but no tumor cells.

A diagnosis of bronchogenic carcinoma with cavitation was made and, after a build-up period, thoracotomy was performed on July 23. The tumor was found inoperable and a small biopsy specimen was taken from the pleura. *Pathologic report:* Very anaplastic, undifferentiated squamous-cell carcinoma, with slight metaplasia to adenocarcinoma.

Comment: The roentgen appearance of this tumor closely resembles that of a huge pulmonary cyst. The irregular, ragged inner contour of the cavity wall, however, immediately suggested neoplasm, although the history and clinical picture were consistent with infected fluid cyst or lung abscess.

CASE II (Fig. 2): A 62-year-old white man came to the Birmingham Veterans Administration Hospital Outpatient Service on Oct. 28, 1947, because of anginal pain occurring in the xiphoid region following exertion. It was a steady, squeezing type of pain

requiring immediate rest for relief. Roentgen examination of the chest on that day revealed a rounded, discrete shadow in the right base which suggested the possibility of abscess, bronchogenic carcinoma of the peripheral type, or a metastatic neoplasm. The patient was hospitalized for further investigation. On Nov. 18, 1947, re-examination disclosed the same shadow, showing evidence of central necrosis, with an irregular inner cavitary wall. The lateral film located the lesion in the middle of the right lower lobe just above the diaphragm.

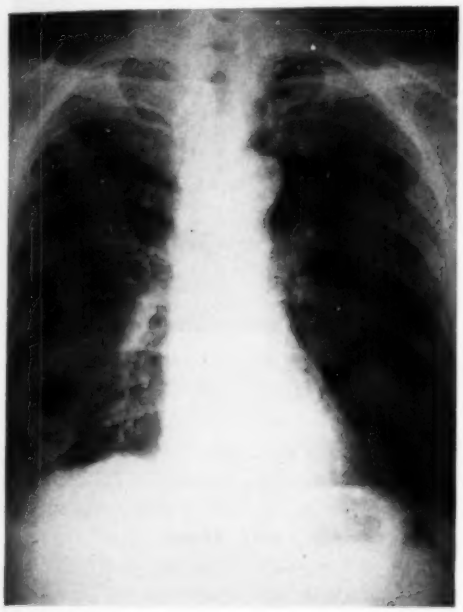

Fig. 2. Case II. Rounded, well circumscribed shadow in right base. Note irregular cavitation in upper part of mass.

The patient gave an additional history of having had a similarly located but smaller lesion pointed out to him on a chest film in 1920. This fact, accompanied by a 3-plus tuberculin skin test, suggested clinically a tuberculoma undergoing excavation. Skin tests for coccidioidomycosis were negative.

Bronchoscopy revealed no evidence of tracheobronchial disease. However, thick non-purulent secretions were noted coming from the right lower lobe bronchus. Cultures of these secretions were negative for acid-fast organisms. There was a heavy growth of non-hemolytic *Staphylococcus aureus*.

In spite of the cardiovascular symptoms and electrocardiographic patterns, which varied from day to day from normal to those suggesting anterior myocardial ischemia, the patient was operated upon on Feb. 11, 1948, and the right lower lobe was removed. The pathological report was squamous-cell bronchogenic carcinoma, peripheral type, undergoing cavitation.

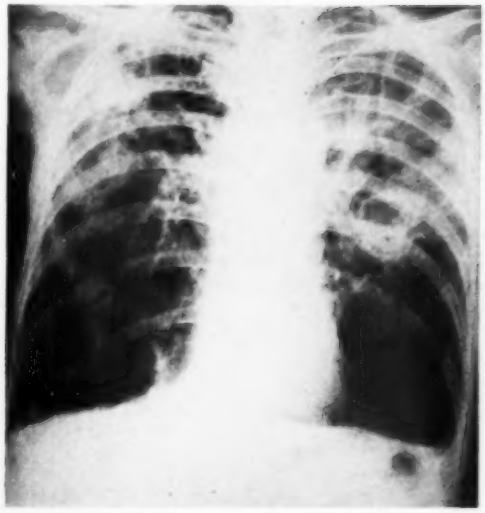

Fig. 3. Case III. Patchy infiltrations in upper two-thirds of both lungs, with scattered nodular calcifications in the right apex and subapex. Two large cavities are seen on the left near the hilus. There is emphysema of both bases, with thickened pleura over the diaphragm and in the costophrenic angles.

Comment: This case illustrates cavity formation in a small tumor. While no definite diagnosis was made preoperatively, radiographically the irregular contours of the cavity wall strongly suggested a malignant neoplasm.

CASE III (Fig. 3): A 74-year-old white man gave a history of pulmonary tuberculosis for forty years, with positive sputum tests at various times at different Veterans Administration hospitals. In the last two months he had lost 27 pounds and noticed increasing weakness. His cough had been growing gradually worse and the sputum was often blood-stained. He entered this hospital on Oct. 15, 1946.

A chest film (Oct. 17, 1946) showed dense infiltrations involving the upper two-thirds of both lungs, with two large cavities on the left. Both bases were emphysematous and the pleura was thickened over the diaphragm and in the costophrenic angles. Sputum was positive for acid-fast bacilli on two occasions. The clinical and roentgen diagnosis was: far-advanced bilateral pulmonary tuberculosis with cavitation.

After a months stay, the patient left the hospital against medical advice, but re-entered two weeks later (Dec. 3, 1946) because of rapidly increasing weakness. He died on Dec. 27, 1946.

On autopsy both lungs were found to be studded with confluent nodules of gray tumor tissue. In the

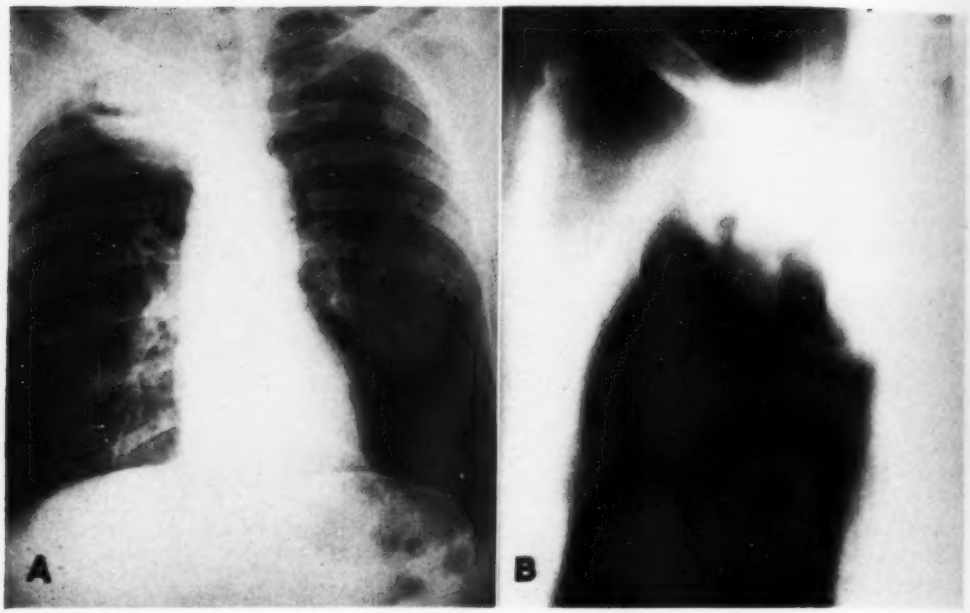

Fig. 4. Case IV. A. Large mass in right apex, well circumscribed below. Note eccentric location of cavity laterally and inferiorly; also, rib destruction. B. Planigram demonstrating markedly irregular and ragged appearance of cavity.

left lung were two large nodules, one 3 cm. and the other 4.5 cm. in diameter, both excavated. Microscopic examination of the cavitating tumors showed them to be composed of groups of undifferentiated squamous cells, occupying the alveolar spaces and invading the perivascular and peribronchial lymph spaces. The tumor cells were anaplastic, had hyperchromatic nuclei, and showed abnormal mitotic figures. There were small rudimentary horn pearls. Careful search was made for tuberculous lesions, on a large number of microscopic sections, but none could be found.

Pathologic diagnosis: 1. Squamous-cell carcinoma, left upper lobe (peripheral type), with multiple metastases to both lungs. 2. Metastasis to the right kidney and adrenal.

Comment: Assuming the recent positive sputum tests to have been correct, indicating the presence of active tuberculosis at the time of death, the failure to find tuberculous lesions postmortem can still be explained by the tremendous predominance of neoplastic tissue. From the roentgenologic point of view, we may assume that the active tuberculosis, if present, was located chiefly in the right upper lobe, because of the presence of an old fibro-calcific lesion in that area. The unique feature of this case is that the cavities in the left upper lobe were neoplastic. The excavation, however, was so complete that no characteristic wall contours could be seen, and no suspicion of cancer was entertained until postmortem examination disclosed the true nature of the lesion.

CASE IV (Fig. 4): A 50-year-old white male entered the hospital on Jan. 14, 1948. He had first noticed pain in the right shoulder blade in July 1947. The pain became gradually worse and eventually involved the entire right upper chest, radiating down the right arm. There had been one attack of hemoptysis in November, yielding 2 or 3 ounces of blood, following which the sputum was blood-streaked for a few days. A weight loss of 15 pounds had occurred in the six months since the onset of pain.

On admission the patient showed a Horner's syndrome, moderate clubbing of the fingers, and tenderness over the right shoulder and scapula. He had a low-grade fever, up to 99° F. X-ray examination of the chest on the day of admission showed a large, well circumscribed mass in the right apex, with irregular cavitation in the lower anterolateral aspect. There was destruction of the anterior half of the first rib and the posterior half of the second rib. Bronchoscopy, on Jan. 15, was negative. Biopsy of a palpable lymph node from the

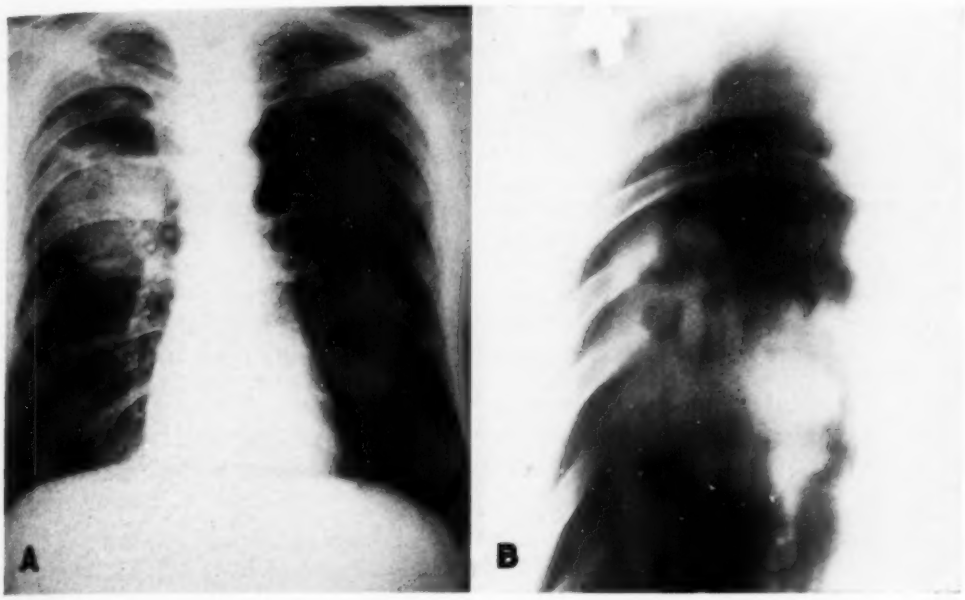

Fig. 5. Case V. A. Round, well circumscribed mass in right upper lung field, with eccentrically located cavity. B. Planigram, demonstrating irregularity of cavitation.

right supraclavicular region was reported as metastatic squamous-cell carcinoma. The tumor was regarded as inoperable.

Comment: This was an obvious case of "superior sulcus tumor" and presented very little diagnostic difficulty, at least as far as determination of its malignant character was concerned. It is presented in this group because it demonstrates the eccentric location and irregular ragged wall of the cavity.

CASE V (Fig. 5): A 38-year-old white man entered the hospital on March 10, 1947, complaining of a cough productive of blood-streaked sputum. This had been present intermittently during the preceding two years and was accompanied by a weight loss of 40 pounds. The patient had been discharged from the Armed Forces at approximately the time of onset of his presenting complaints, but six months later was refused employment because a chest film showed a "spot on the lung." A roentgenogram of the chest obtained on March 12 showed a large mass in the right upper lung posteriorly. It was fairly well marginated along its lower border. Planigrams showed ragged multilocular cavitation eccentrically located in the apical portion of the tumor. Biopsy of a palpable axillary lymph node showed reticulum-cell sarcoma. The patient was transferred elsewhere for deep x-ray therapy.

Comment: This case has been included in the present group because it again demonstrates the eccentric location of the cavity and the irregular, ragged contours of the cavity wall.

SUMMARY AND CONCLUSIONS

Early differential diagnosis between inflammatory and malignant lesions of the lung is not always possible. Moreover, no pathognomonic signs of pulmonary neoplasm exist at any stage of the disease, either clinically or roentgenographically. Cough, hemoptysis, pain in the chest, and weight loss, in a patient over forty years of age, must be assumed to indicate a pulmonary neoplasm until proved otherwise.

The type of pulmonary neoplasm most often confused with infection is the cavitary form of bronchogenic carcinoma. Roentgenologically, differentiation must be made from infected fluid cyst, lung abscess, and tuberculosis. The eccentric location and irregular, ragged inner contour of the cavity should direct attention to the probability of a malignant growth.

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SUMARIO

Forma Cavitaria de Neoplasia Pulmonar

No siempre es posible hacer el diagnóstico diferencial temprano entre las lesiones inflamatorias y malignas del pulmón. Tampoco existen signos patognomónicos, ni clínicos ni radiográficos, de neoplasia pulmonar en ningún período de la dolencia. Hasta que se demuestre lo contrario, debe presumirse que la presencia de tos, hemoptisis y pérdida de peso en un sujeto de más de cuarenta años indica neoplasia.

El tumor pulmonar que más a menudo se confunde con infección es la forma cavitaria del carcinoma broncógeno. Roentgenológicamente, hay que diferenciar el último, de quiste seroso infectado, absceso pulmonar y tuberculosis. La localización excéntrica y el contorno interno mellado e irregular de la cavidad deben hacer pensar en la probabilidad de tumor maligno.

High-Kilovoltage Radiography[1]

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LIKE THE OTHER factors involved in radiography, the kilovoltage factor has been the subject of almost continuous study. The equipment available has always had a profound influence on the voltage range over which routine work could be done. At no time has there been any universally accepted technic for any single part of the body. Personal preference and experience have in general been the dominant factors in determining the kilovoltage used in most laboratories.

In its infancy radiography was limited, by the generators and tubes available, to relatively low voltages. With the advent of the alternating current transformer, mechanical rectifiers, and the Coolidge tube, the kilovoltage was increased. The universal type, fine-focus Coolidge tube was frequently used at 100 kv.p. for radiography of the lumbar spine and the chest in large patients.

When the radiator-type tube became available, the voltage was limited to 85 kv.p., a limitation willingly accepted because of the improved definition made possible by the smaller focal spot. For some years, the voltage factor received little attention, as improved films and screens and increased tube current reduced the exposure time required. During this period, there was a general tendency toward higher contrast through the use of reduced voltage. There were some centers of influence, however, where increased latitude was preferred at the expense of contrast, at least for some regions of the body.

In the last few years, the question of the use of higher kilovoltage has become the subject of considerable discussion. This would seem to be the result of a number of contributing influences. Notable are the works of Fuchs, Hodges, Morgan, and their associates. The recent works of Lamerton and of de Waard have contributed to a better understanding of scattered radiation, always of prime importance when the effect of voltage on the radiograph is to be considered.

No small part of the interest in increased voltages can be traced to their use in mass radiography. Further impetus has come from renewed interest in cineradiography and fluoroscopic intensification.

The work reported here had its inception in some work done by Files and his coworkers in 1944 and 1945 during their search for an optimum ratio grid. A dry spine and wire mesh suspended in a water phantom were used as test materials. It was soon evident that increased grid ratios (greater than 8:1) were feasible and that they made possible a marked reduction in the amount of scattered radiation reaching the films. Grids of ratios as high as 34:1 were studied. At the increased ratios, the exposure time became so great that, to reduce it to usable limits, higher voltage became necessary. As the voltage was increased, the exposure decreased, as had been anticipated, but at a rate considerably in excess of that expected. The higher ratio grids made possible a high degree of contrast even at much higher voltages than were in general use at the time. As the voltage was increased, one disturbing factor crept into the picture. This was a seeming loss of definition occurring between 110 and 120 kv.p. and persisting at all voltages above this. At the time it was thought that this might be caused by some change in the grain characteristics of the intensifying screens. During that period, the study of grain char-

[1] Presented at the Thirty-fourth Annual Meeting of the Radiological Society of North America, San Francisco, Calif., Dec. 5–10, 1948.

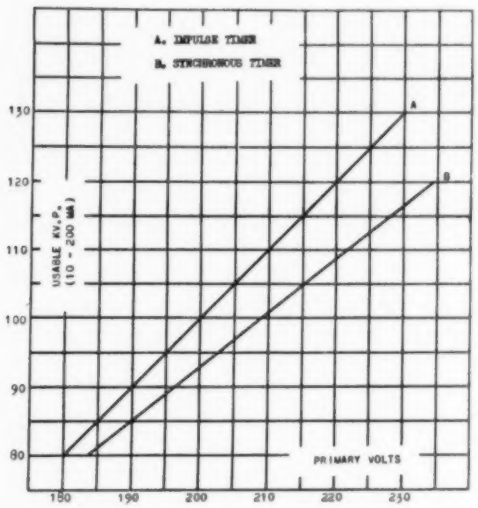

Fig. 1. Primary voltage *vs.* usable kilovoltage for a high-voltage system using an impulse timer (A) and a synchronous timer (B).

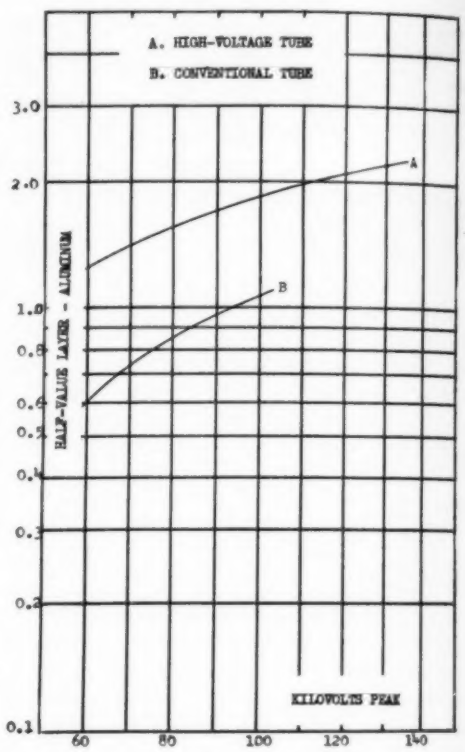

Fig. 2. Half-value layer *vs.* kilovoltage for a rotating-anode tube of conventional design and a similar tube designed for operation at 130 kilovolts.

acteristics in film emulsions for use with million-volt radiation in industry was bringing to light some hitherto unexpected facts, and consideration was given to a possible similar effect at lower voltages with light-sensitive materials. At that point, Files' death brought about a temporary halt in the work.

It had become apparent, however, that higher ratio grids were feasible and that a ratio of 16:1 was about the optimum. At that ratio, the improved contrast seemed to just about balance the increased exposure at a practical level.

When work was resumed in 1946, attention was at once focused on the seeming loss of resolution that occurred at voltages above 110 kilovolts. By use of the Morgan method of measuring resolution, it was determined that the use of voltages as high as 135 kv.p. did not result in any change in this respect with any of the screen and film combinations then available.

One possibility after another was explored until it was determined that the apparent loss of definition was due to scattered radiation reaching the back screen from the cassette back and the Bucky tray. A thin sheet of lead on the inside surface of the cassette back was the readily apparent solution. With that barrier passed, there seemed to be no technical reason why higher voltages could not be used to produce radiographs of satisfactory contrast with the higher ratio grids.

Before proceeding further, it was deemed advisable to investigate the changes that might be necessary in equipment to make possible the use of the higher voltages. Fortunately, diagnostic transformers were already available for operation up to 135 kv.p. at reduced current for superficial therapy. The behavior of these transformers and their controls was studied using high-voltage, short-time exposures at tube currents up to 200 ma. It was found that with minor modifications of bushings and high-tension switches, the operation of such transformers was satisfactory at voltages up to 130 kv.p., and tube cur-

rents up to 200 ma., providing consideration was given to the method of switching used to initiate and terminate the exposure. The so-called "synchronous" timer consists of a timing mechanism driven by a synchronous motor. The motor operates at constant speed, providing accurate time intervals, but the exposure may be started or ended at any point in the voltage wave. If the switching operation takes place at any point other than the zero point in the voltage wave, switching transients are set up in the high-voltage system. At voltages about 120 kv.p. these transients may reach a level that will bring about a failure of the insulation somewhere in the high-voltage transformer and tube system.

The impulse type of timer is not only driven at constant speed but, in addition, is so designed that it initiates and terminates the exposure at the instant the voltage passes through zero. As a result, no transients are set up, and such a timer makes possible satisfactory operation at any voltage up to the rating of the high-voltage system and the tube with which it is used. The use of the impulse timer is advisable at any voltage where its timing range is adequate. With present tubes and transformers, its use is mandatory for voltages about 120 kv.p.

The data from which this conclusion is

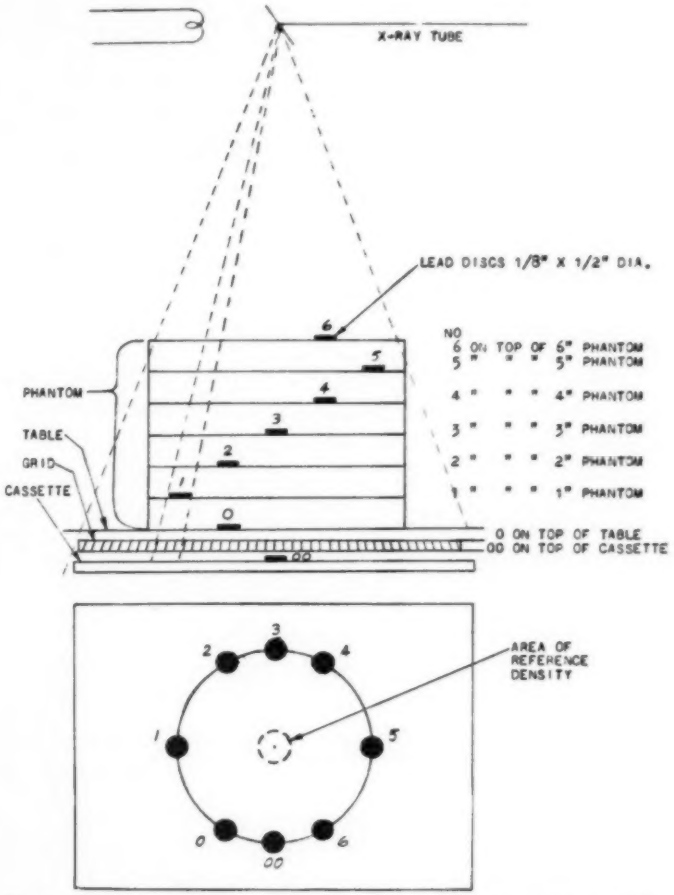

Fig. 3. Diagram of a method used to study the relative efficiency of grids and motivating mechanisms.

drawn are plotted in Figure 1. Here, the primary voltage is plotted against the usable voltage that will not inject harmful transients into the high-voltage system when the two types of switching are used.

Some modification of the x-ray tube and container was found to be necessary. The changes had to do chiefly with improved ventional rotating-anode tube and a similar tube designed for operation at voltages up to 130 kv.p. Radiographic studies indicate that this increased filtration does not produce a perceptible change in radiographic quality at voltages above 40 kv.p. Below 40 kv.p. there is a decrease in background density.

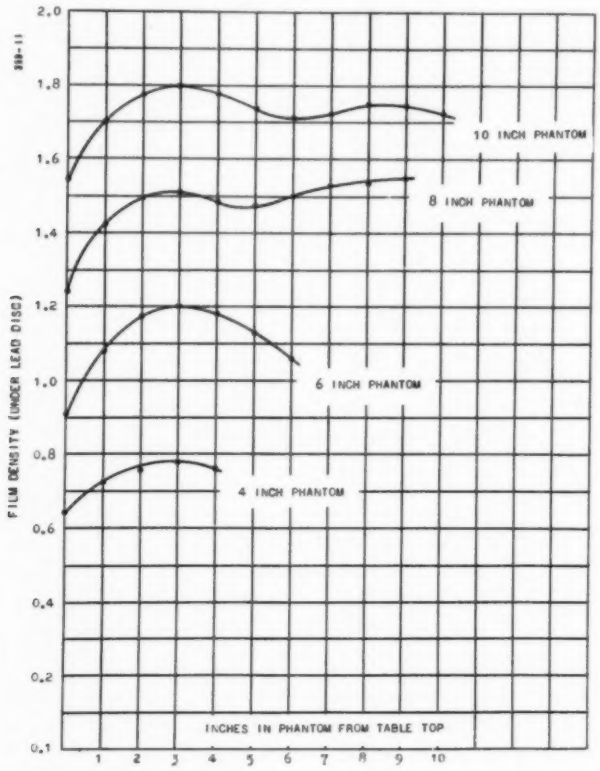

Fig. 4. Results plotted from data taken at 100 kilovolts peak with an 8:1 grid in a single-stroke mechanism and phantom thicknesses of 4, 6, 8, and 10 inches.

dielectric conditions. One of these changes was an increase in the thickness of the tube window to decrease the possibility of puncture at the higher voltages. The increase in window thickness, of course, resulted in an increase in the inherent filtration of the tube system. The extent to which this change influences the quality of emitted radiation can be seen in Figure 2. Here, the half-value layer in aluminum has been plotted against voltage for a con-

At this point the project seemed to be completed. Tubes and energizing equipment for operation at voltages up to 130 kv.p. did not require any radical changes that might make their cost prohibitive. The 16:1 grid made possible excellent contrast. Voltages above 130 kv.p. did not seem warranted, for at 130 kv.p. exposures were so short as to begin to tax present timing methods.

The project was not closed out at this

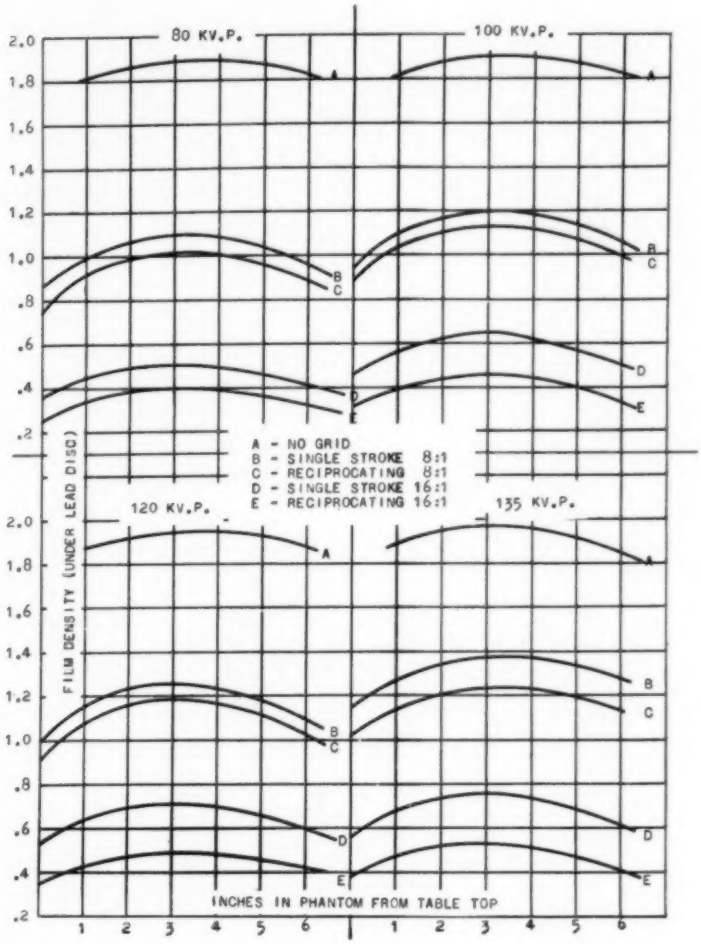

Fig. 5. Data showing film density produced by scattered radiation using 8:1 and 16:1 grids in single-stroke and reciprocating mechanisms.

point, however, because the Liebel-Flarsheim reciprocating Bucky became available. Up to this time, the work had been done using the single-stroke Bucky mechanism. The reciprocating mechanism was so attractive from many functional points of view that it seemed worth while to review the whole problem.

It had gradually become apparent that some better method was needed to evaluate the results produced by the different grids and their motivating mechanisms. It was becoming too difficult to evaluate the radiographs visually, and the number of exposures involved prohibited the use of patients as test material.

In a study previously carried out on another problem, it had been necessary to find a test material that could be used for radiographic tests. Water and other liquids imposed handling and container difficulties. Masonite gave a mottled pattern that made it difficult to measure film densities. Dr. Frank Schulze of the Chemical Divison of the E. I. du Pont de Nemours Company suggested a material that proved to be so satisfactory that it has been used for all subsequent work. This material

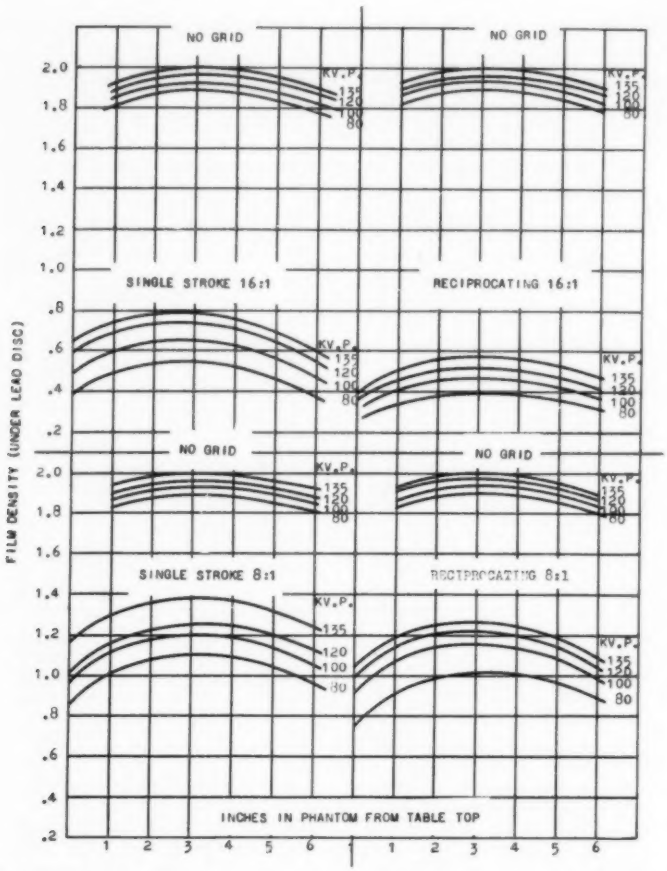

Fig. 6. Film density produced by scattered radiation for each of four grid-mechanism combinations at 80, 100, 120, and 135 kilovolts.

is essentially the material used in printers' inking rollers. Its base is brown glue. Properly prepared, it has a density very close to unity. Thickness for thickness, it compares very favorably with average tissue. It can be prepared in sheets that can be stacked to make up a test phantom of any reasonable thickness. One must be prepared to tolerate a not-too-pleasant odor during the curing period.

In reviewing the literature on methods for evaluating grids, one cannot fail to be impressed by the work of Wilsey in the early days of the Potter-Bucky diaphragm. After a review of all the possibilities, it was decided that if modern technology was applied, Wilsey's ideas could be expanded and refined to give a method that could be used to procure a graphic evaluation of the efficiency of any grid system.

Figure 3 shows the method finally used. A number of lead discs 1/2 inch in diameter were cut from 1/8-inch sheet lead. One of these, designated as *00*, was placed directly on top of the cassette. One, designated as *0*, was placed on the table top. Others, designated as *1*, *2*, *3*, *4*, etc., were placed in the phantom material at corresponding 1-inch levels, as measured from the table top. Thus, if a 6-inch phantom was being used, disc number *2* was in the phantom 2 inches from the table top, and disc number 6 was on top of the phantom and 6 inches from the table

top. By arranging the discs in a spiral in the phantom, their images appeared on the film in a circle. Exposures were made to bring the film density at the center of this circle to some selected density. Having done this, the film densities under the lead discs were a measure of the scattered

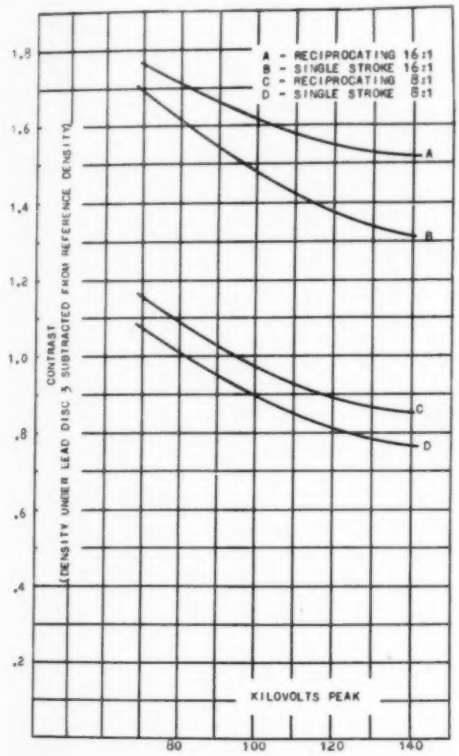

Fig. 7. Contrast number *vs.* kilovolts peak for 8:1 and 16:1 grids in single-stroke and reciprocating mechanisms.

radiation reaching the film from the various levels in the phantom. The density under disc *00* was due to chemical fog produced in processing, that under disc *0* was due to radiation scattered into the volume between the table top and the film, that under disc *1* was due to radiation scattered into the volume defined by the disc and one inch of phantom, etc. When the density under disc *00* (fog density) was subtracted from the density under the lead discs, the resulting values became measures of the

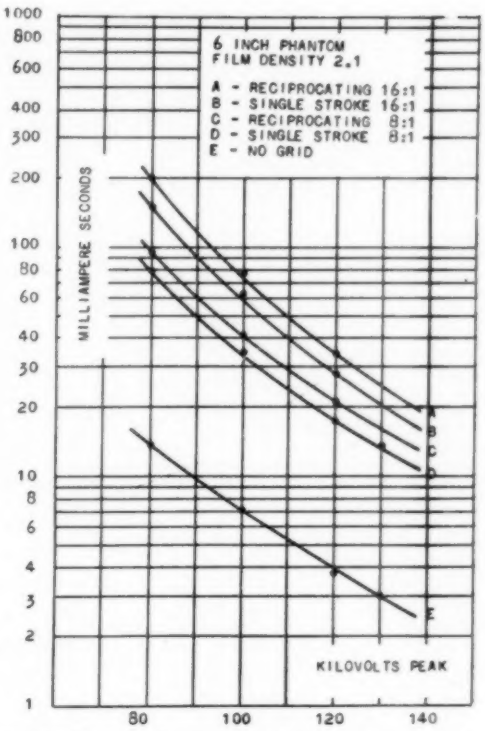

Fig. 8. Comparative exposures in milliampere-seconds *vs.* kilovolts peak for a 6-inch phantom.

efficiency with which any grid and motivating mechanism prevented scattered radiation from reaching the film. Furthermore, it provided a measure of the contrast that could be expected at various voltage levels.

Carefully controlled exposures were necessary to bring the reference density in the center of the circle formed by the discs to an exact reference density. Control of the film processing was one of the most difficult problems encountered. In general, the procedure was to explore a given set of conditions until all factors had been decided upon. A complete series of films covering the variable under study was then exposed and processed at one time.

In Figure 4 are plotted the data from a study made at 100 kv.p. at 40 inches using an 8:1 grid in a single stroke mechanism with phantoms *4*, *6*, *8*, and *10* inches thick. The reference density was 2. As might be expected, the density due to scattered

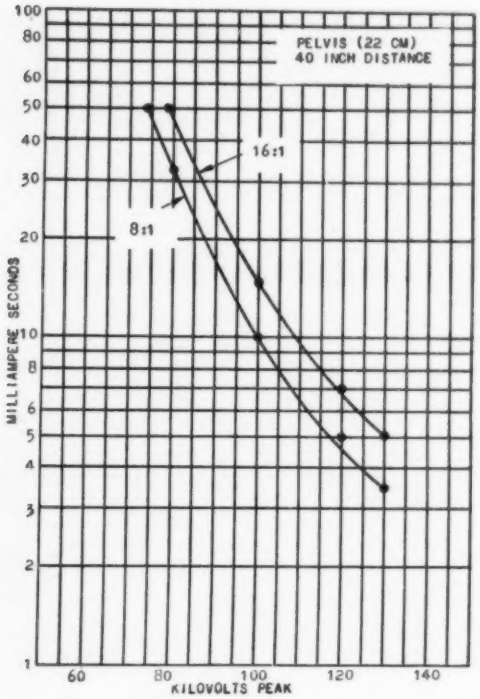

Fig. 9. Exposure *vs.* kilovolts peak for radiograph of a pelvis, using 8:1 and 16:1 grids in a reciprocating mechanism.

radiation increased as the phantom thickness increased. An increase from 4 to 8 inches just about doubled the density under disc number *3*. The unexpected thing was that the density always was at a maximum under this disc. This condition prevailed over the more than one hundred radiographs made under all conditions over a period of some months. There may be a simple explanation for it but, if so, the authors made no hit upon it.

Four sets of conditions were studied at voltages of 80, 100, 120, and 135 kv.p. These conditions involved an 8:1 grid in a single stroke mechanism, the same grid in a reciprocating mechanism, a 16:1 grid in the single stroke mechanism, and a 16:1 grid in a reciprocating mechanism. Medium-speed screens with the usual radiographic films were used. No special chemicals were employed in processing the exposed films.

A set of data taken with a 6-inch phantom with no grid and with the various grid combinations is shown in Figure 5. It is readily seen that the 8:1 grid in the reciprocating mechanism removes more of the scattered radiation than the same grid in a single-stroke mechanism. The same is true with the 16:1 grid, and the improvement with either grid in the reciprocating mechanism becomes more pronounced as the voltage is increased. It is also seen that the 16:1 grid in either mechanism when used at 135 kv.p. produces a higher degree of contrast than is obtained with the 8:1 grid at 80 kv.p.

TABLE I: COMPARATIVE EXPOSURE DATA FOR PELVIS (22 CM.)

Grid	Kv.p.	Ma.	Factor
8:1	80	32	1.00
8:1	100	10	0.45
8:1	120	4.6	0.14
8:1	130	3.5	0.11
16:1	80	46	1.00
16:1	100	15	0.33
16:1	120	6.9	0.15
16:1	130	5.0	0.11

TABLE II: COMPARATIVE EXPOSURE DATA FOR LATERAL LUMBAR SPINE (30 CM.)

Grid	Kv.p.	Ma.	Factor
8:1	80	200	1.00
8:1	100	75	0.37
8:1	120	39	0.20
8:1	130	30	0.15
16:1	80	400	1.00
16:1	100	125	0.31
16:1	120	55	0.14
16:1	130	40	0.10

In Figure 6 the same data are plotted to bring all the values for a single grid and mechanism together. For purposes of record, a contrast number was obtained by subtracting the density under disc *3* from the reference density. The comparative exposure characteristics of the two grids and two mechanisms are shown in Figure 8 for a 6-inch phantom.

Having determined that the reciprocating mechanism was preferable to the single-stroke mechanism and that the 16:1 grid could be used to produce satisfactory contrast at the higher voltages, the next step was to transfer the experimental results into the making of radiographs on living subjects. In making patient radio-

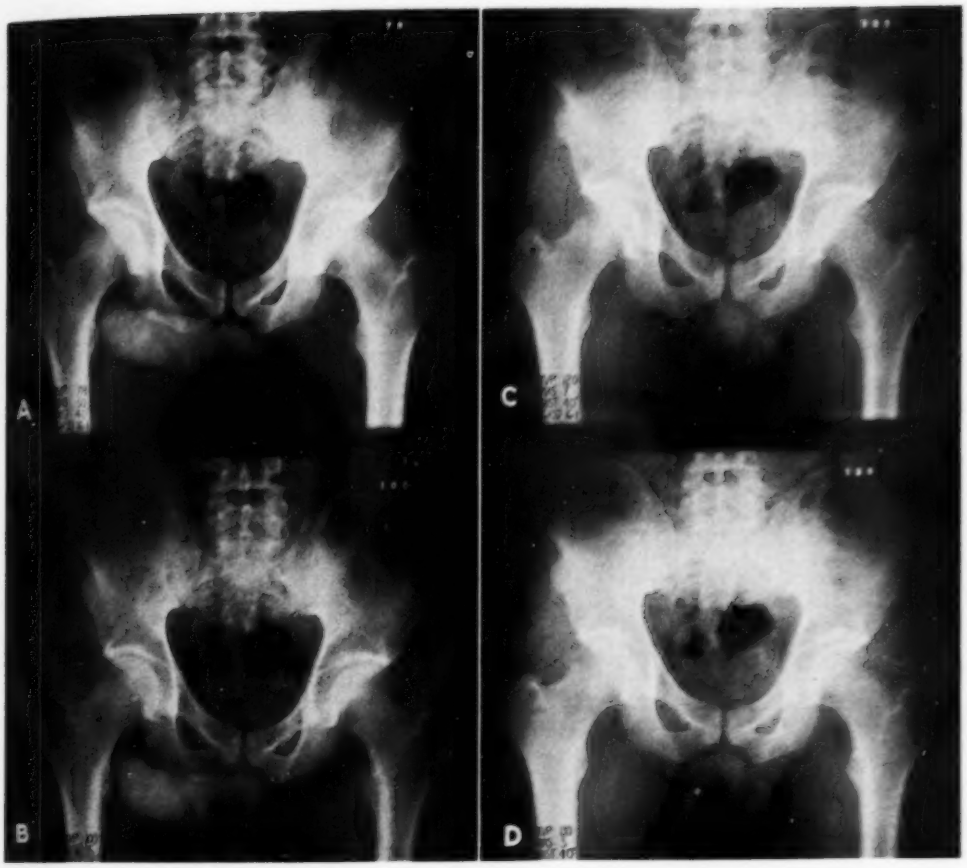

Fig. 10. Radiographs of pelvis using 16:1 reciprocating grid at 78, 100, 120, and 130 kilovolts peak. A. 78 kv.p., 50 ma., 40 in. distance, 16:1 grid. B. 100 kv.p., 15 ma., 40 in. distance, 16:1 grid. C. 120 kv.p., 7 ma., 40 in. distance, 16:1 grid. D. 130 kv.p., 5 ma., 40 in. distance, 16:1 grid.

graphs, densities were matched visually, as would be the case in actual practice.

As might be expected, a pelvis was the first part studied. The results using the 8:1 and 16:1 grids in the reciprocating mechanism are plotted in Figure 9 and tabulated in Table I. The relative exposure for each grid at 80, 100, 120, and 130 kv.p. is shown in the last column. It will be seen that the exposure with the 16:1 grid is about one and one-half times that for the 8:1 grid at any given voltage. For a given exposure at the 75 kv.p. level, the 16:1 grid requires an increase of about 4 kv.p. over the 8:1 grid. This increases to about 12 kv.p. at the 120 kv.p. level.

It is difficult to show other than gross differences in radiographs when they are reduced to print, but it is hoped that Figure 10 will serve to indicate the type of radiographs used in arriving at the data shown.

Similar results obtained from radiographs of a lateral lumbar spine are shown in Figure 11 and Table II. Differences between the comparative exposure factors for the pelvis and the spine are probably due to the inability of the eye to match densities exactly and the difference in contrast levels that further complicate the problem for the eye. In all cases, the densities were probably more nearly uniform than those encountered in actual practice.

The results to be expected with higher

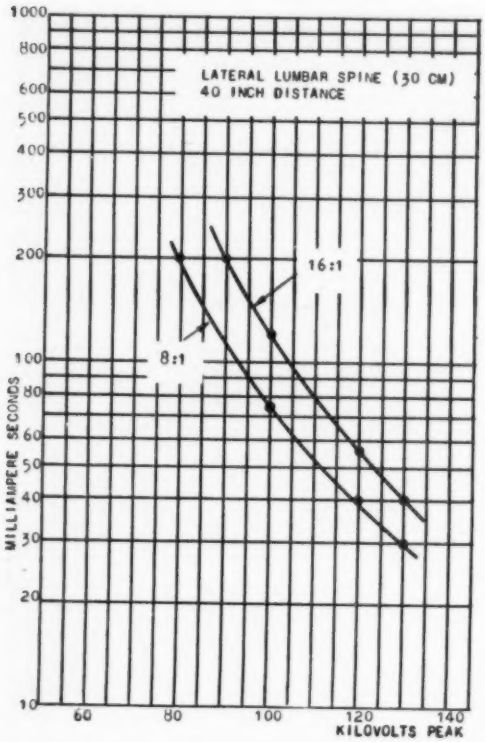

Fig. 11. Exposure *vs.* kilovolts peak for lateral lumbar spine, using 8:1 and 16:1 grids in reciprocating mechanism.

TABLE III: COMPARATIVE EXPOSURE DATA FOR POSTERO-ANTERIOR CHEST RADIOGRAPH (22 CM.)

Grid	Kv.p.	Ma.	Factor
None	60	10	1.00
None	80	3	0.30
None	100	1.2	0.12
None	120	0.6	0.06
None	130	0.5	0.05
5:1	80	6	1.0
Stationary grid	100	2.5	0.42
	120	1.4	0.23
	130	1.0	0.06

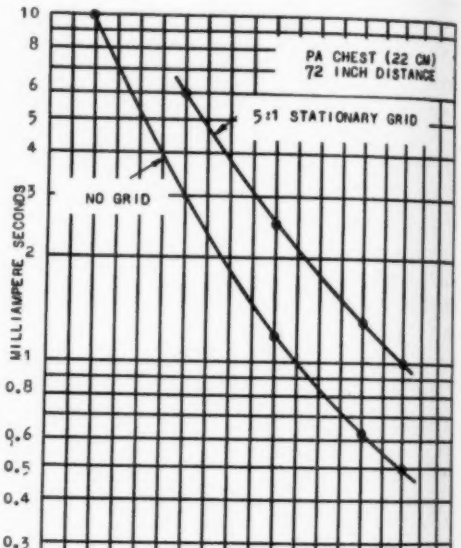

Fig. 12. Exposure *vs.* kilovolts peak for postero-anterior chest radiograph.

voltage in the postero-anterior and lateral radiography of the chest were studied without a grid and with a stationary focused grid. The grid used was focused for 42 inches and had a ratio of 5:1. Radiographs were made using a 72-inch distance. The results are shown in Figs. 12 and 13 and Tables III and IV. Some idea of the type of radiographs possible may be had from two such series shown in Figures 14 and 15.

The opportunity to see what might be done with radiography of an extremity could not be ignored. Two series of radiographs of a leg were made without a grid. One series was made using intensifying screens, the other using no-screen film. The results are plotted in Figure 16.

To date hundreds of radiographs have been made. The impression persists that films of high quality are possible at the higher voltages. The contrast can be maintained by using the 16:1 grid. The latitude is especially striking in these radiographs. For the first time, it becomes possible to put on the medical films something approaching the qualities obtained in industrial radiography, where heavy lead filter screens are used at voltages up to one and two megavolts. Over a wide range of voltage, the changes are such as to leave little doubt of the value of higher voltages

TABLE IV: COMPARATIVE EXPOSURE DATA FOR LATERAL CHEST RADIOGRAPH (32 CM.)

Grid	Kv.p.	Ma.	Factor
None	80	20	1.00
None	100	8	0.40
None	120	4	0.20
None	130	3	0.15
5:1 Stationary grid	80	40	1.00
	100	16	0.40
	120	8	0.20
	130	6	0.15

for some types of work. High voltage and the increased latitude that goes with it may not always be desirable. Fortunately, the changes in equipment to make the use of higher voltages possible does not preclude the use of presently accepted technics to obtain radiographs with the characteristics now looked on as desirable. The use of high-ratio grids and higher voltages should be looked upon as a means of obtaining an improved result in certain types of work, this result being obtained with short exposures without loss of contrast.

One of the interesting possibilities which we have not had time to work on is the use of higher voltages with the fine-grain type of intensifying screen usually referred to as "detail" or "high"-definition screen. The use of higher voltages may make the routine use of such screens possible, since the exposure time need not be prohibitive.

Not the least interesting thing on which to speculate is the effect of increased voltage on the exposure which is received by the patient. As pointed out earlier in this discussion, the increased inherent filtration in the tube necessary for high-voltage operation brings about an increase in the half-value layer of the emitted radiation. This is, of course, accompanied by a de-

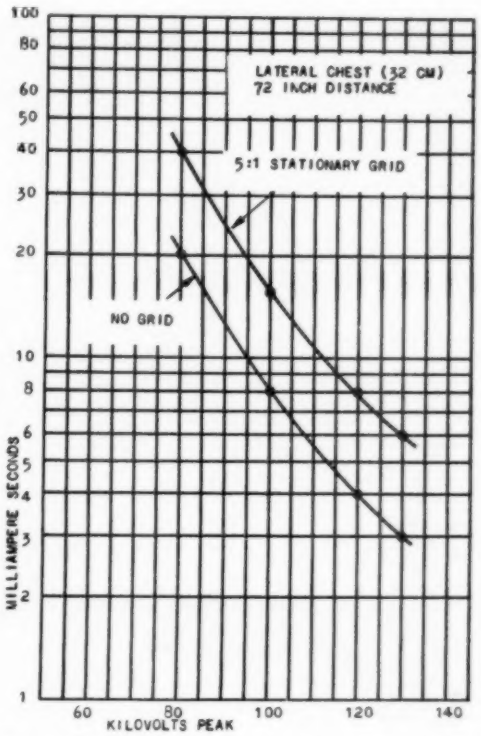

Fig. 13. Exposure *vs.* kilovolts peak for lateral chest radiograph.

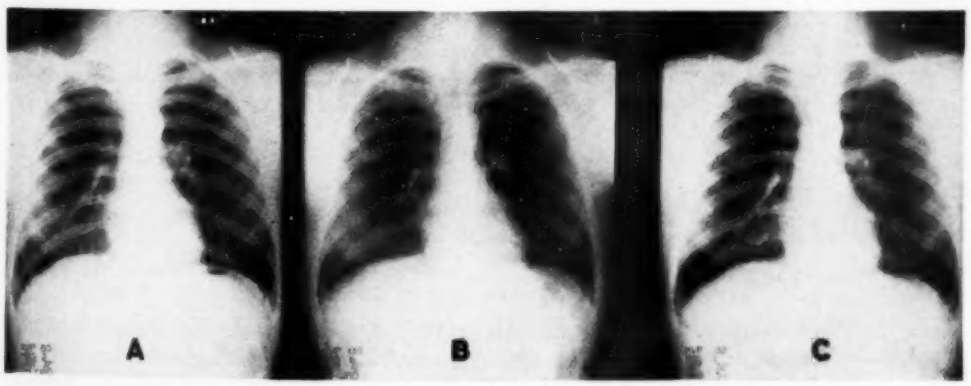

Fig. 14. Postero-anterior radiographs of chest. A. 80 kv.p., 3 ma., 72 in. distance, no grid. B. 130 kv.p. 1/2 ma., distance 72 in., no grid. C. 130 kv.p., 1 ma., 72 in., 5:1 grid.

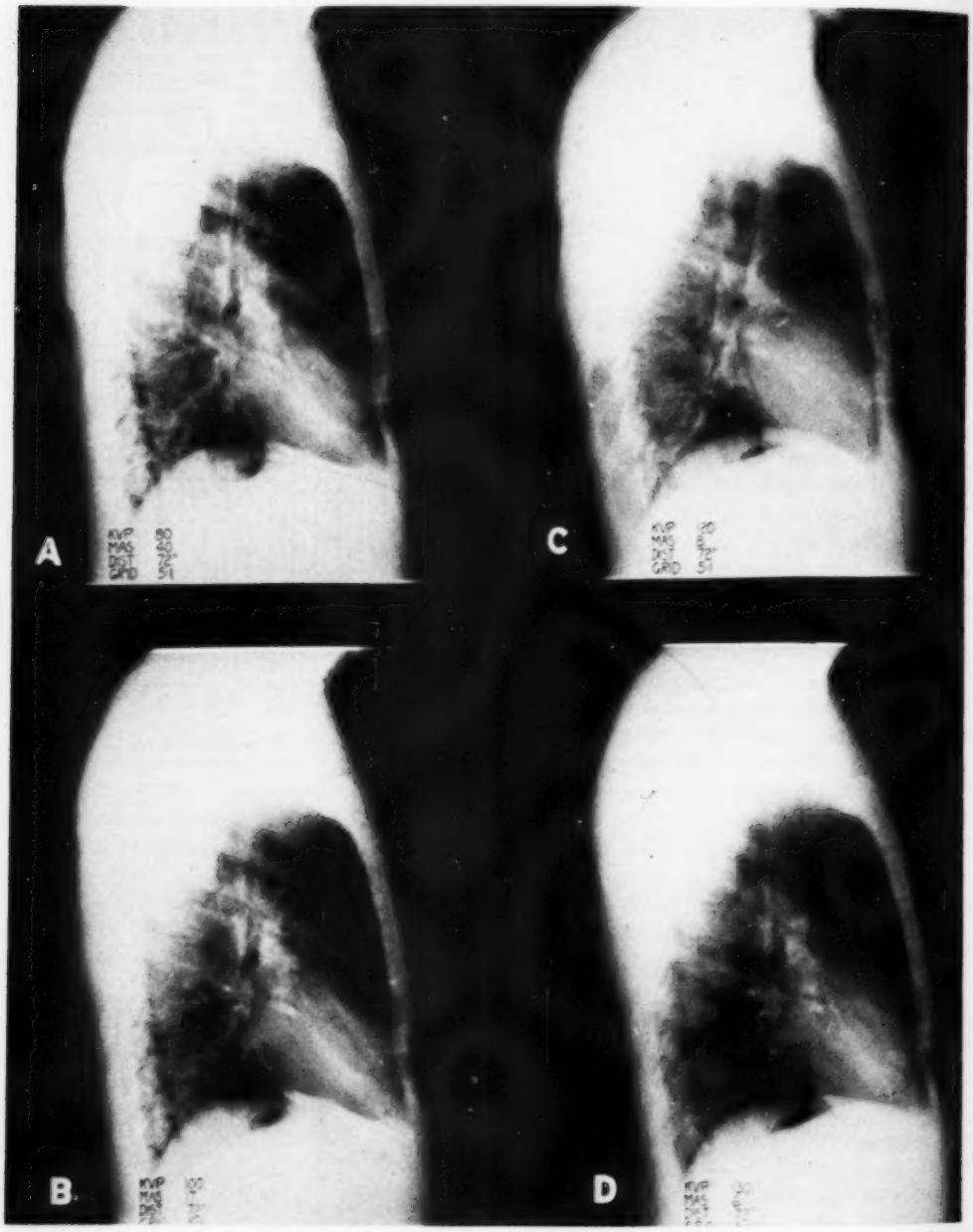

Fig. 15. Lateral radiographs of chest. A. 80 kv.p., 40 ma., 72 in. distance, 5 : 1 grid. B. 100 kv.p., 17 ma., 72 in. distance, 5 : 1 grid. C. 120 kv.p., 8 ma., 72 in. distance, 5 : 1 grid. D. 130 kv.p., 6 ma., 72 in. distance, 5 : 1 grid.

crease in the intensity in roentgens per milliampere-second. The order of this change can be seen in Figure 17, in which is plotted the intensity obtained from the tubes used for the major portion of the work reported here. It will be noted that the intensity from the high-voltage tube is about one-half that from the conventional tube. An analysis of the skin exposure in the case of an 8-inch (20-cm.) pelvis is of

interest. The conventional tube used at 80 kv.p. and a 40-inch focal film distance would deliver 0.023 r per milliampere-second to the skin. Using the 8:1 grid, an exposure of about 30 milliampere-seconds would be required, bringing the dose to the skin to about 0.7 r.

If the high-voltage tube and the 16:1 grid were used at 130 kv.p., the intensity

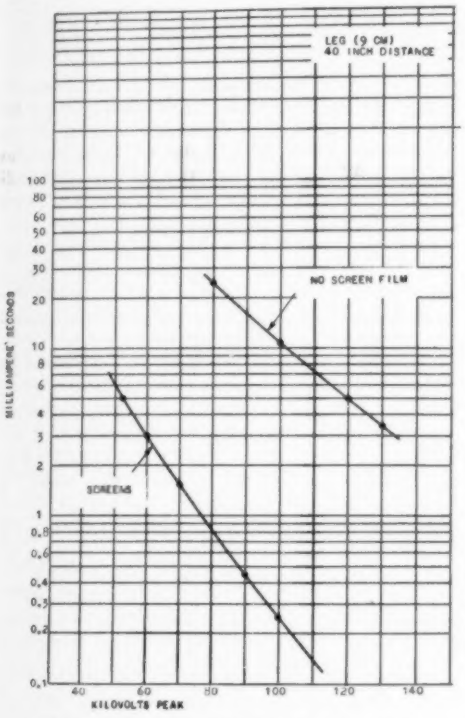

Fig. 16. Exposure *vs.* kilovolts peak for leg.

would be approximately 0.019 r per milliampere-second. The exposure would be about 5 milliampere-seconds and the skin dose only 0.095 r. Something approaching the same result could, of course, be had by adding aluminum filter to the conventional tube.

The skin dose may not be the whole story, however; if effects at a depth are to be considered, the penetrating qualities of the radiation must be taken into account. In Table V will be found data taken using the two types of tubes and the phantom employed throughout these studies. It will be seen that through four inches of the material, the transmission will be 2.5 per cent at 80 kv.p. with the conventional tube and 5.8 per cent at 130 kv.p. with the high-voltage tube. Under these conditions in the radiography of the pelvis, previously mentioned, the transmitted dose through four inches would be 0.0175 r for the 80-kv.p. technic and only 0.0055 r for the 130-kv. technic. From this, it would seem that from the standpoint of both the skin dose and the dose to parts below the surface the evidence is in favor of the higher voltage even when the 16:1 grid is used.

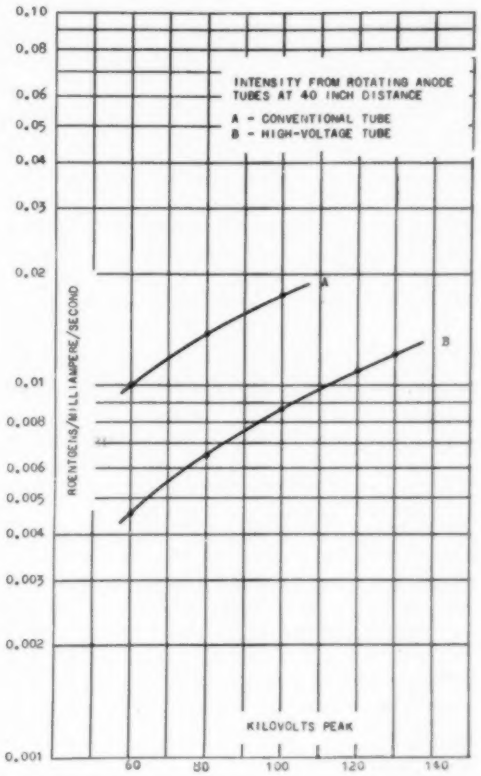

Fig. 17. Intensity *vs.* kilovolts peak for conventional and high-voltage rotating-anode tubes.

In conclusion it can be said that:

(1) The use of voltages up to 130 kv.p. is possible without major redesign of equipment.

(2) The use of higher ratio grids in a

TABLE V: TRANSMITTED RADIATION THROUGH PHANTOM

Phantom (Inches)	Per Cent Transmission							
	Conventional Tube			High-voltage Tube				
	60 kv.p.	80 kv.p.	100 kv.p.	60 kv.p.	80 kv.p.	100 kv.p.	120 kv.p.	130 kv.p.
0	100	100	100	100	100	100	100	100
1 (2.5 cm.)	17	24	25	25	28	34	36	37
2 (5.1 cm.)	6	10	12	9.4	12	16	17	18
3 (7.7 cm.)	2.6	4.8	6	4.0	6.0	8.0	9.4	10
4 (10.0 cm.)	1.2	2.5	3.4	1.8	3.0	4.2	5.4	5.8
5 (12.7 cm.)	0.56	1.3	2.0	0.84	1.6	2.5	3.2	3.4
6 (15.3 cm.)	0.27	0.7	1.2	0.40	0.86	1.5	1.9	2.1
7 (17.9 cm.)	0.13	0.4	0.7	0.19	0.48	0.90	1.15	1.25
8 (20.4 cm.)	....	0.2	0.44	....	0.26	0.57	0.70	0.78

reciprocating mechanism makes it possible to use the higher voltages without a loss of contrast.

(3) The use of the higher voltages increases the latitude to a marked degree.

(4) The use of the higher voltages reduces the exposure to such a level that large patients can be radiographed with shorter exposures than was previously possible.

(5) The patient dose is reduced by the use of higher voltages.

NOTE: The authors are indebted to A. L. Pace, who did the work on grid evaluations.

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DISCUSSION

Russell Morgan, M.D. (Baltimore, Md.): I find it difficult to assimilate all of these data in a few minutes. However, I think that the curves that were presented showing the amount of radiation to which the patient is subjected as the voltage goes up are rather significant. These curves are similar to some that we have obtained. You will notice that the dosage diminishes progressively as the voltage increases from 60 kv. on up into and beyond the 130-kv. range.

From conversations that I have had with many manufacturers of x-ray equipment, it looks as though the costs are going to be materially increased by going to the voltages above the 100-kv. level, and from the work that we have done, we are a little doubtful as to whether the benefits to be achieved are sufficient to offset these economic factors. It begins to look as though the cost of an x-ray generator for high-voltage radiography will be about twice that of a similar generator for 100-kv. work, and for my radiographic money I would prefer to have two radiographic rooms equipped with two radiographic generators of 100 kv. than to have one room with a generator that could go up to 140 or 150 kv. That, of course, is a matter of personal preference, and I would be interested to hear some other comments on this subject.

Paul C. Hodges, M.D. (Chicago, Ill.): If the films made at these higher voltages are significantly better than the best that can be produced conventionally, then we will have to discard our old equipment. The reduction in tissue dosage is laudable, of course, and the shortening of time worth while in the raying of moving parts such as stomach and bowel, but the real question is: Will we be able to make clinically better lateral pelvic roentgenograms of heavy subjects?

Unfortunately I was not able to see Mr. Trout's exhibit but I shall be on the lookout for his publication.

Ross Golden, M.D. (New York): Three or four years ago, I had the opportunity of seeing some films of some big shells, I believe they were 16-inch shells, taken with one-million-volt x-rays. I was much impressed by the fact that the metal casing could be clearly seen, inside of which was the lesser density of the TNT, and inside the TNT

were air bubbles. In spite of the tremendous voltage, the air bubbles were not obliterated. In clinical radiology, the thing that has impressed me the most is the extraordinary latitude on these higher-voltage films. I like short wave lengths for certain purposes—for example, certain joints—because the rays show bone structure and still do not black out the soft-tissue shadows. I believe that the future will show a usefulness for these higher-voltage machines, of which we have but little concept at the moment. I hope that Mr. Trout and his colleagues will continue their experiments.

Mr. Trout (*closing*): I want to thank the discussants, because that's exactly why we trotted the horse out here this afternoon. You never know whether a horse can run until you put him in a race.

I'm not nearly so pessimistic as Dr. Morgan as to the cost of equipment. I think that for milliamperages up to 200 we have adequate high-tension transformers. Any marked changes that I can see must come in the controls; the change in the tube should be at a minimum. From talking with some of the boys in the tube development section, I gather that the change in the rotating anode to fit the higher voltages would create an additional cost of about $60.00 to the radiologist. I would guess, if guessing—and I want you to remember that it is strictly a guess, and I don't want to be called to account for it—that the increased cost of the generator system will be considerably less than double the present cost.

I'm sorry that Dr. Hodges didn't get a chance to see our films, as we value his opinon very highly. The chief difference that you begin to notice as you go up in kilovoltage is the increase in latitude.

Those of us in industrial radiography during the war received a liberal education in voltages up to two million. We're now building, for industrial radiography, equipment up to ten million volts, so the voltage doesn't scare us too much. The marked increase in latitude is always evident, and we do have available these short exposures for the heavy parts that have caused us considerable difficulty for a number of years. I'm going to be surprised if there is any change in transformer size, because, as the voltage goes up, the current may come down, so that the things will pretty well balance out. I expect that the big field of development, if this thing has possibilities, will be in the same direction that we went when we took a million and two million volt equipment into industry. The film and screen grain size was reduced, so that we got some gain in that direction.

SUMARIO

Radiografía de Alto Kilovoltaje

Las ventajas que pueden obtenerse con el empleo de voltajes más altos en roentgenografía han suministrado tema para discusión por algunos años. Este trabajo describe una serie de experimentos que han abarcado todas las fases del problema. Observóse que:

(1) El empleo de voltajes hasta de 130 kv. p. resulta posible sin mayor cambio de la instalación.

(2) El empleo de rejillas de razones más altas en un mecanismo reciprocador permite utilizar los voltajes más altos sin pérdida de contraste.

(3) El empleo de los voltajes más altos acrecienta notablemente la latitud.

(4) El empleo de los voltajes más altos rebaja a tal punto la exposición que los enfermos grandes pueden ser radiografiados con exposiciones más breves que las que eran posibles antes.

(5) El empleo de altos voltajes reduce la dosis por enfermo.

Cinefluorography

A Progress Report on Technical Problems, Dosage Factors, and Clinical Impressions[1]

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THE POSSIBILITY of cinefluorography being a procedure of considerable diagnostic importance has appealed to radiologists and others for more than three decades. Its promise, of course, is the improved visualization of the motion of organs and structures now inadequately seen during fluoroscopy. The origin of the technic, and its development to 1930, have been recounted by Jarre in *The Science of Radiology*. His bibliography includes all important early contributions. Since then, workers in both hemispheres, including South America and the Far East, have taken advantage of continued improvements in lenses, fluorescent screens, films, and x-ray generating apparatus, to bring both direct cineradiography and indirect cinefluorography to a level of practical usefulness.

Our interest is in the indirect procedure. The term cinefluorography has been used previously for the indirect method, and we believe it to be an accurate one to describe the making of motion pictures of x-ray images on the fluoroscopic screen.

We began our evaluation of cinefluorography about two years ago. The experimental 16-mm. cinefluorographic apparatus that we first employed and the 35-mm. equipment that we subsequently adopted have been described by Watson and Weinberg. In the development of these devices and their use, we have had material assistance from representatives of manufacturers of x-ray generating apparatus, lenses, fluoroscopic screens, films, and processing chemicals, and from members of the University of Rochester Department of Optics.

Cinefluorography has been employed for the clinical study of a number of selected cases in our department. As the clinical interest developed, a room was set aside for this sole purpose. The cases investigated have included problems involving swallowing, motility of the alimentary canal, joint motion, and the action of the heart and of the lung structures. The volume of cases studied has not yet been sufficient to permit a statistically adequate evaluation of the diagnostic usefulness of the technic. These studies, however, are proceeding, and the results will be published later. We desire in this paper to describe some refinements of apparatus, the technical procedures we employ, the rationale of the exposure—hence dosage—factors used, and to present some of our tentative impressions thus far of the clinical values of cinefluorography.

TECHNICAL CONSIDERATIONS

The initial description of our 35-mm. cinefluorographic equipment was written by Watson and Weinberg in June 1948. Since that time the speed range of the camera has been increased from an upper limit of 32 frames to 60 frames per second. This has the advantage of permitting moderately slow-motion studies of rapid action such as that seen in swallowing. The increase in speed has necessitated the use of a high-speed camera shuttle in place of the standard shuttle. Also, the revolving lead shutter, used at slower speeds to interrupt the x-ray beam during the pull-down phase of the camera cycle, has been temporarily discarded, and the same result achieved more neatly by changing over

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from full-wave to half-wave rectification. This clever expedient was suggested to us by an article on the work of Rehman of the University of Southern California.

By converting to half-wave rectification, half of the impulses are suppressed and the energy output of the remainder is doubled by increasing the filament current. Proper synchronization of the x-ray generator with the camera shutter permits activation of the tube, and thus of the fluoroscopic screen, only during the open phase of the camera shutter. In most cameras, this is about one half of the camera cycle.

Synchronization of the camera shutter rotation with the power impulses energizing the tube is quite easily accomplished by the use of a synchronous motor of sufficient torque to drive the camera. However, synchronization of rotational speed, so that the camera mechanism completes one cycle for each complete cycle of the power frequency, is not enough; it is also necessary to ensure that the camera shutter is open during the particular half cycle that the tube is energized. Fortunately, the armature of a synchronous motor, when in step with the power frequency, has certain reproducible angular positions corresponding to the zero points of the power line alterations. The number of these for any given motor depends upon its rated speed. A 3,600 rpm. (60 rps.) motor will have two cycle points 180 degrees apart, and a 1,800 rpm. (30 rps.) motor will have four 90 degrees apart, etc. By coupling the motor so that the camera shutter will be open to concur with the energy pulse of the power frequency, the first of the synchronization problems is solved. Every time the motor attains synchronization, the proper relationship of the camera shutter to the zero points of the power cycle will be achieved.

Opening of the camera shutter may occur, however, during either of the half cycles of the alternating current wave, and there is no simple way to ensure that the seating of the motor will concur with the energization periods of the x-ray equipment. It is therefore necessary to label

Fig. 1. Commutator on synchronous motor. Pencil points to small insulated segment which causes an interruption of the circuit. This is seen as a break in the sine wave on the oscilloscope.

the power cycles in some way, and to provide a means of changing the relative position of the open phase of the camera shutter to correspond. In our apparatus, a commutator (Fig. 1) on the motor shaft, bearing an insulated segment which passes under a brush during the time that the shutter is open, is used to interrupt the low-voltage alternating current supply to the vertical plates of a cathode ray oscilloscope which is adjusted to show one complete cycle upon its screen (Fig. 2). This interruption produces a break in the smooth sine wave of one of the half cycles seen on the screen, thus labeling it as the one during which the shutter is open. By experiment, it has been determined which one of these corresponds to the half cycle energizing the tube. If the shutter opening occurs in the proper half cycle, exposure can begin at once. If it does not

occur in the proper half cycle, it is necessary to shift the angular position of the shutter opening until the proper relationship is obtained. This can be done by interrupting the power supply to the motor for a short period in the hope that, when the motor again comes into step, it will be in the proper angular phase. This is the method which we first used, but since several trials were frequently necessary to establish the proper synchronization, and since at 60 frames per second approximately 4 feet of film pass through the camera per second, this method resulted in a waste of film. A system was therefore devised which permitted the relative angular position of the camera drive to be shifted quickly through an angle of 180 degrees with reference to the motor shaft while at full speed. This permits positive synchronization of the camera shutter with the proper half cycle of the power alternation without great delay and has effected a considerable saving of film.

Starting the camera drive motor has also presented a problem. The particular motor used is designed for use on a 220-volt supply, and can be started on this full voltage. When this is done, however, the motor accelerates to full speed very rapidly (in a fraction of a second) and it was feared that this rapid acceleration would break the film or possibly damage the camera mechanism. For this reason, a semi-automatic system of reduced-voltage starting was adopted, in which about 70 volts is first applied to the motor to start its rotation. This is gradually increased by a variable transformer to 110 volts, at which voltage the motor will run near full speed, though not in reliable synchronization. Switches then automatically disconnect the 110-volt supply and apply a full 220 volts to the motor, at which time it comes into step and is ready for use.

When this system is in proper synchronization, the camera shutter is open for 1/127 second, during which time an x-ray impulse occurs and the film remains stationary. The shutter then closes and remains closed for 1/113 second, during which time the film is moved to the next frame and there is no x-ray output. For a three-second run that results in the production of 180 images and uses 11 1/4 feet of film for the actual recording of the images, another 8 feet of film are wasted in starting the camera and about 4 feet are lost in stopping.

With a synchronous motor camera drive, it is possible to use reduction gears to slow the camera speed. With the proper gear reduction, a rotary circuit breaker may be used to interrupt the primary circuit of the high-tension transformer in phase with the power frequency in the manner of an impulse timer. This will permit the use of lower camera speeds (at any sub-multiple of 60 frames per second) and retain the advantages of synchronization of shutter opening with x-ray output.

It has been found necessary to protect the film magazine with lead, but the several elements in the lens seem to provide ample protection from radiation during the time the film is in or passing through the shuttle.

X-Ray Technical Factors: A DuPont-Patterson E-2 fluoroscopic screen and Kodak Linagraph Ortho film, 35-mm. (green sensitive) are utilized. The x-ray generator employed is the KX-1 and the x-ray tube is a CRT 1-2, both manufactured by the General Electric X-ray Corporation. This generator has ample capacity for all types of cinefluorographic work. The valve tubes are air-insulated and any pair may be readily removed to convert the generator to half-wave rectification. With the approval of the manufacturer, the CRT x-ray tube was used above its rated capacity, and has been adequate for all our requirements.

One hundred kilovolts is a constant factor for all exposures, and the milliamperage is varied from 75 for thin parts to 150 for areas of greater opacity. At 100 kilovolts the tube with an added filter of 1 mm. of aluminum gives a half value layer of 2 mm. of aluminum and an estimated threshold erythema of 350 r. The tube output, at 150 ma. at a distance of 24 inches, is 4.5 r per second measured

in air. The target-screen distance utilized is altered from 29 to 50 inches, depending on the thickness of part and whether or not a stationary grid is employed. When the maximum camera speed of 60 frames per second is used, these radiographic factors permit the recording of adequate densities for all parts of the body except the trunk below the diaphragm in adults.

Film Processing: For the cinefluorographic process to be as efficient as possible, it is most important that optimum speed and contrast be obtained in the final record. Hence, it is essential that one use the most favorable processing procedures—those recommended by the manufacturer. Actually, to make the most of the minimum exposures obtained, we develop the film to a very high gamma. The necessity for attention to these details cannot be over-emphasized. Experience has shown that, despite the use of entirely suitable technical arrangements and exposure factors, it is all too easy to produce records of poor technical quality because of careless or incorrect film processing.

PROTECTION OF TECHNICAL PERSONNEL

The personnel operating our cinefluorographic equipment is carefully monitored by film badges and pencil electrometers under the supervision of a physicist. At no time has anyone received a daily dose greater than 0.05 r. This is made possible by the fact that the complete procedure can be carried out by a single technician and that, as a rule, patients are selected who can co-operate fully. During cinefluorography the technician and any medical or nursing personnel present stand behind an adequate protective barrier.

DOSAGE

It has been difficult to gain any definite ideas from the literature as to the dosages employed in previously published cinefluorographic work. Stewart, whose technical factors produced an erythema in forty-eight seconds, limited his exposures to five seconds per examination. Some investigators have used doses as high as a full erythema, without apparent concern. Nor is it easy to arrive at a conclusion, from the general literature, as to what really constitutes a tolerance factor to radiation injury for a single exposure. In our work, the protection of the patient from undue dosage of radiation is given careful and constant consideration. At the outset we decided to keep the exposures as close to the range commonly utilized for routine radiographic examinations as possible, and to limit the amount of radiation reaching the skin to a small fraction of a skin erythema dose.

As a preliminary step, a radiologic history is obtained with particular attention to such factors as possible employment of the patient in radiation laboratories and the amount of radiation that may have been received during diagnostic x-ray examinations or x-ray therapy. At first

Fig. 2. Sixty-cycle sine wave on oscilloscope, showing break in upper half of wave. Each half of wave represents one impulse. (1/120 second)

we employed a filter of 0.5 mm. of aluminum added to the tube filtration but soon changed to a filter of 1.0 mm. of aluminum. This, of course, further decreased the skin dose, with little significant loss of radiation at the fluoroscopic screen. In addition, an adjustable lead diaphragm is employed to narrow the x-ray beam to the areas under observation. The favorable factors of synchronization of the x-ray output and the camera shutter opening, and of a 29- to 50-inch target-screen distance have already been discussed. To eliminate any additional exposure because of retakes, the patient is rehearsed prior to the cinefluorography. This includes a rehearsal viewed on the fluoroscopic screen at the usual low fluoroscopic exposures. During this latter rehearsal, a note is made of the interval necessary to record one cycle of movement of the organ or structure being examined, so that only one cycle need be x-rayed.

It is our practice to limit the exposure used in any single examination to a maximum of 25 r, with every effort to reduce this dosage to 15 r or less if possible. This level of dosage has seemed to be reasonably safe from the standpoint of the patient and to be within the range of diagnostic exposures. Table I presents data from different sources on the dosages that are utilized in various routine diagnostic x-ray examinations. These are not strictly comparable because of the different methods used in their compilation. The wide dosage range is also a reflection of the variation in diagnostic technics used in different laboratories. Compared with these data, 25 r is not an excessive dose.

An added factor of safety is the low depth dose characteristic of radiographic exposure factors. Braestrup has provided data, reproduced as Table II, that indicate the average dosage in roentgens for 80-kv. radiation. Our depth dose is estimated to be somewhat higher.

TABLE I: COMPARISON OF DOSAGES PER EXPOSURE (EXPRESSED IN ROENTGENS) OF VARIOUS ROUTINE X-RAY EXAMINATIONS

	Turnbull	Martin	Strong Memorial Hospital
Fluoroscopy	30.0 r/min.	15.0 r/min.	11.0 r/min.
Chest	0.4 r	0.4 r	0.05–0.15 r
Skull	13.0 r	1.0–4.0 r	0.3–0.8 r
Gastro-intestinal	1.0 r	1.0–8.0 r	0.5 r
Gallbladder	1.7 r	1.5–4.0 r	0.5 r
Vertebral Column	.....	5.0 r	0.5–8.0 r
Pelvimetry	.....	10.0–24.0 r	2.0–12.0 r
Urinary Tract	.....	0.5–1.5 r	0.25–0.6 r

PROJECTION AND VIEWING

To save time in an emergency, it is possible to project the developed negative as soon as it is dry, a practice said to be popular with newsreel editors. Ordinarily, however, the 35-mm. negative is first printed on fine-grain 16-mm. positive type film, thus protecting the negative from damage and insuring a screen picture of superior projection quality. Sixteen-millimeter film is preferred to 35-mm. in making the print, for reasons of convenience and economy in projecting, handling, etc. Special optical printing effects, such as speeding up or slowing the action, may be introduced directly while making the reduction print, or, when necessary, a master print and duplicate negative on 35-mm. film can be used as intermediary steps. We agree with previous workers in this field that a really careful study of any scene is best done by running it through the projector as an endless loop, repeating it over and over, until every phase of the action has been analyzed, and everyone is sick of looking at it.

SOME IMPRESSIONS OF THE CLINICAL VALUE

We have used cinefluorography in the study of about seventy clinical cases selected in our department or by clinicians in other hospital services. While we cannot as yet give any evaluation of the clinical usefulness of cinefluorography based on adequate and controlled study, we can say that we are enthusiastic about its possibilities. So also are several orthopedic surgeons, otorhinolaryngologists and others who are sending us cases for this special examination. By means of cinefluorography, it is possible to study essentially the same phenomena that can be viewed

TABLE II: AVERAGE DOSAGE (IN ROENTGENS) FOR EACH 100 MILLIAMPERE-SECOND EXPOSURE AT 80 KV.P. AND 0.5 MM. AL ADDED FILTRATION (From Braestrup: Radiology **38**: 213, 1942)

Target skin distance Approximate target film distance	12 in. 24 in.	16 in. 28 in.	20 in. 32 in.	24 in. 36 in.	28 in. 40 in.	5 ft. 6 ft.
r in air	14	7.8	5.0	3.5	2.6	0.56
r at skin	17	9.7	6.2	4.3	3.1	0.68
r at 3 cm. depth	8.2	4.8	3.2	2.2	1.7	0.39
r at 5 cm. depth	5.1	3.1	2.1	1.5	1.1	0.26
r at 7 cm. depth	3.1	1.9	1.3	0.90	0.72	0.17
r at 10 cm. depth	1.6	1.1	0.71	0.54	0.40	0.10

fluoroscopically. In addition, the details of moving organs and structures can be seen far more clearly and can be studied at leisure.

The slow motion provided by films made at a camera speed of 60 frames per second is particularly advantageous in the study of processes involving rapid motion. We believe that cinefluorography permits an appreciation of the normal dynamics of the more active and complex vital functions, an appreciation which cannot be obtained by routine x-ray examinations.

Perhaps the most useful information obtained so far has been in the field of orthopedic surgery. There have been several cases involving the motion of the cervical vertebrae and at least one example of hip movement, in which the clinicians believed that the information recorded was of assistance. There is also a growing opinion among the orthopedists here, that cinefluorography will aid materially in the elucidation of some of the complex motions characteristic of cerebral palsy and related conditions. Our studies of swallowing have been interesting and at the same time rather baffling. In one instance the surgeon was able to differentiate which of a series of esophageal strictures was in need of surgical correction and which could be treated conservatively. On the whole, however, we have not had enough experience with the dynamics of swallowing to interpret all that we see. Therefore, these cases are being examined with particular interest.

The ability to visualize activity clearly and repeatedly is of particular advantage in studies of heart action, the motion of pulmonary structures, the passage of opaque media through the alimentary canal and blood vessels. A complete analysis of any one region or function is a complex problem. Enough has been observed to indicate that accurate conclusions will be derived only from study by members of the preclinical and clinical departments working together.

SUMMARY

This paper describes the cinefluorographic equipment and the methods now being used in the Department of Radiology, University of Rochester School of Medicine and Dentistry. The technical and dosage factors are discussed and a progress report on the clinical value of cinefluorography is presented.

The apparatus developed at the University of Rochester could be duplicated for general use, since all necessary component parts are commercially available.

ACKNOWLEDGMENT: We desire to express our sincere appreciation for the advice and assistance provided in this study by Mr. George Struck, Eastman Kodak Company; Mr. George Happe and Mr. C. H. Morris, General Electric X-Ray Corporation; Mr. W. H. Turner and Dr. Emory Meschter, E. I. duPont de Nemours and Company; Professor Brian O'Brien, Department of Optics, University of Rochester, and Mr. B. W. Thomas for his help in processing the film, and to Mr. William Cornwell and Dr. R. J. Bloor for their help in writing the paper.

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SUMARIO

Cinefluorografía: Repaso Periódico de los Problemas Técnicos, Factores Posológicos e Impresiones Clínicas

Aparacen aquí descritas la instalación y las técnicas que emplean para cinefluorografía en el Departamento de Radiología de la Facultad de Medicina y Odontología de la Universidad de Rochester, N. Y. Se utilizan películas de 30 mm., habiéndose alcanzado una velocidad de sesenta exposiciones por segundo. Los problemas técnicos planteados por el procedimiento fotográfico son discutidos. Los factores radiográficos empleados son: 100 kv., 75 a 100 ma., según el espesor de la parte en estudio, 1.0 mm. de filtro de aluminio, dando una capa de hemirreducción de 2 mm. de aluminio, distancia foco-piel de 72.5 cm. a 1.25 m. Cuando se utiliza la máxima velocidad de la cámara de 60 exposiciones por segundo, esos factores permiten registrar densidades adecuadas para todas las partes del cuerpo, exceptuando, en los adultos, el tronco más abajo del diafragma. La exposición usada en cualquier examen aislado no pasa de un máximo de 25 r, haciéndose todo esfuerzo para rebajarla a 15 r o menos, si es posible.

Para la impresión se prefiere la película de 16 mm., por razones de conveniencia y economía en la proyección y el manejo.

El lento movimiento que facilitan las películas obtenidas a razón de 60 exposiciones por segundo resulta en particular ventajoso en el estudio de los procesos que entrañan movimientos rápidos, como en los estudios de la acción cardíaca, el movimiento de los tejidos pulmonares y el pase de medios opacos a través del tubo digestivo y de los vasos sanguíneos. A los AA. también les ha resultado útil en el campo de la cirugía ortopédica.

Los aparatos elaborados en la Universidad de Rochester pueden ser duplicados para uso general, pues todas las piezas se hallan de venta en el comercio.

Heart Measurement

A Simplified Method[1]

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RECENTLY HODGES (1) and Schwarz (2) have described in this Journal the technical details and nomograms that have been used in this laboratory for determining heart size in the teleroentgenogram, either from planimeter measurement of frontal plane area or from linear measurement of the long and short diameters of the frontal plane silhouette. In both instances, several steps were involved in finally obtaining heart size expressed in percentage variation from normal.

The purpose of this paper is to see how far one can go in simplifying heart measurement in adults without any significant loss in accuracy. It became apparent that, in order to attain this objective, three things would be desirable:

(1) To eliminate calculation of divergent distortion for each individual patient and, instead, obtain an average distortion factor which could be applied to all subjects.

(2) To avoid making an outline of the complete cardiac silhouette, using only those borders which can be seen on the chest film.

(3) To combine in one nomogram the equation for predicting normal size with the equation for measured size in such a way that percentage variation from normal could be read directly.

In order to obtain an average divergent distortion factor, one must always take the chest film in the same manner, preferably at a distance where divergent distortion is reduced to a minimum consistent with a reasonable exposure time. Since our routine chest films have been taken at a 72-inch target-film distance with the anterior chest surface closest to the film, and since this is also the common practice elsewhere, it was selected as my standard technic. The only variable then is the distance of the heart from the film, a factor which varies with the anteroposterior diameter of the chest. To determine if variation in divergent distortion between subjects was really significant, 100 adult patients were selected at random, with wide differences in height, weight, and heart size, as shown in Tables I to V. The divergent distortion correction factor was figured individually, based on the anteroposterior chest diameter of each patient, and the result was recorded. The average divergent distortion correction factor was 0.89, obtained by adding the individual correction factors together and dividing by 100. The range extended from only 0.87 to 0.91, despite the fact that anteroposterior chest diameters varied from 16.5 cm. to 29 cm. Therefore, the greatest possible deviation from the average or mean is about 2 per cent of the total frontal plane area, an insignificant figure.

As the next step in simplification, one would like to avoid making a tracing of the complete cardiac outline, particularly since the upper and lower borders are drawn empirically. The product of the long and short diameters multiplied by a correction factor will give a reasonable approximation of frontal plane area. In order to avoid drawing the empiric upper and lower heart borders, I measure the long diameter, L, from the junction of the right heart border and great vessels to the cardiac apex, and the short diameter, S, from the junction of the left heart border and pulmonary conus to the right cardiophrenic angle (Fig. 1). These two diameters, as a

[1] From Division of Roentgenology, The University of Chicago, Chicago, Ill. Accepted for publication in April 1948.

TABLE I: NORMAL HEARTS (±10%)

X-ray or Unit No.	Height (cm.)	Weight (kg.)	AP Chest Diameter (cm.)	Planimeter Method			Diameter Method					Predicted Area (sq. cm.)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq. cm.)	Divergent Distortion Correction Factor	Net Area (sq. cm.)	Long Diameter (cm.)	Short Diameter (cm.)	L × S*	Agp/L × S†	Net Area (sq. cm.)			
U 413,123	151	64.5	22.0	108	0.89	96	13.5	10.4	140.4	0.769	95	89	+8	+6
82,006	162	55.4	20.0	111	0.90	100	13.4	10.9	146.0	0.760	99	96	+4	+3
79,594	173	87.4	24.0	146	0.88	128	14.9	12.6	187.7	0.777	127	116	+10	+9
80,625	171	54.4	18.5	108	0.90	97	12.7	11.8	150.0	0.720	101	103	−6	−2
116,981	170	68.4	21.5	122	0.89	109	13.9	11.6	161.0	0.757	109	107	+2	+2
116,996	172	56.8	19.0	114	0.90	103	13.8	10.7	148.0	0.770	100	105	−2	−5
116,982	181	81.0	23.5	140	0.89	125	15.1	12.8	193.0	0.726	131	122	+2	+6
116,997	155	49.5	18.0	97	0.90	87	11.9	10.5	125.0	0.776	85	87	0	−2
116,998	157	63.6	25.0	107	0.88	94	13.1	10.7	140.0	0.764	95	94	0	+1
116,993	167	58.6	21.0	122	0.89	109	13.6	11.8	160.2	0.761	109	102	+7	+7
116,995	160	66.0	20.0	118	0.90	106	13.6	11.3	153.8	0.767	104	98	+8	+6
116,980	164	59.0	20.5	110	0.90	99	12.8	11.2	143.4	0.766	97	99	0	−2
122,915	173	76.6	22.5	133	0.89	118	13.8	12.6	174.0	0.764	118	113	+5	+5
117,037	177	73.6	21.0	136	0.89	121	14.9	12.1	180.0	0.755	122	115	+5	+6
117,029	147	47.6	16.5	94	0.91	86	12.2	10.3	125.8	0.748	85	80	+8	+6
117,024	177	76.5	22.0	145	0.89	129	14.8	13.2	195.0	0.744	132	117	+10	+13
116,991	157	58.2	21.0	114	0.89	101	13.5	10.9	147.0	0.775	100	93	+8	+7
116,990	166	59.0	21.0	108	0.89	96	12.8	11.1	142.0	0.760	96	100	−4	−4
116,999	157	59.0	19.0	99	0.90	89	12.3	10.4	128.0	0.773	86	92	−3	−6

For explanatory details, see Table V, page 696

TABLE II: SLIGHTLY ENLARGED HEARTS (+11% TO +25%)

X-ray or Unit No.	Height (cm.)	Weight (kg.)	AP Chest Diameter (cm.)	Planimeter Method			Diameter Method					Predicted Area (sq. cm.)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq. cm.)	Divergent Distortion Correction Factor	Net Area (sq. cm.)	Long Diameter (cm.)	Short Diameter (cm.)	L × S*	Agp/L × S†	Net Area (sq. cm.)			
U 412,736	155	51.3	22.0	119	0.89	106	13.7	11.3	155.0	0.767	105	88	+20	+19
132,470	177	76.0	23.0	146	0.89	130	15.5	13.1	203.0	0.719	137	116	+12	+18
125,269	170	55.0	19.5	143	0.90	129	15.5	12.6	195.0	0.733	132	103	+25	+28
115,605	151	60.6	26.0	120	0.88	106	13.2	11.9	157.0	0.764	106	88	+20	+20
83,027	172	70.0	20.5	142	0.89	127	15.3	12.2	186.6	0.761	126	110	+15	+14
59,967	183	82.5	26.5	165	0.88	145	15.6	13.3	208.0	0.793	140	123	+18	+14
21,616	167	65.0	18.5	137	0.90	123	14.8	12.2	180.5	0.759	123	103	+20	+20
52,651	163	62.4	19.0	130	0.90	117	14.0	11.9	166.5	0.780	113	99	+18	+14
127,649	171	96.0	27.5	151	0.87	131	15.5	12.5	194.0	0.778	131	118	+11	+11
99,227	180	82.0	21.5	156	0.89	139	15.8	13.2	208.5	0.746	141	121	+15	+16
79,711	165	79.7	26.0	143	0.88	126	15.8	12.4	196.0	0.730	133	107	+18	+24
79,003	170	64.0	19.5	145	0.90	131	15.4	12.7	195.7	0.740	133	106	+24	+25
77,939	160	51.2	17.5	121	0.90	109	13.8	11.9	164.4	0.735	111	93	+17	+19
80,785	185	79.6	21.0	171	0.87	149	17.3	13.2	238.0	0.718	155	124	+20	+25
87,606	153	54.5	20.5	115	0.90	103	13.5	11.8	159.0	0.723	108	87	+18	+23
77,880	163	66.2	20.5	128	0.89	114	13.7	12.4	170.0	0.753	115	99	+15	+16
76,727	175	73.0	19.0	158	0.90	142	15.5	12.8	198.0	0.798	134	113	+25	+18
111,293	171	67.3	20.5	132	0.90	119	15.3	11.5	176.0	0.750	119	107	+11	+11
117,088	167	52.0	20.0	132	0.90	119	14.5	11.8	171.0	0.772	116	99	+20	+17
122,019	154	54.4	18.0	110	0.90	99	12.8	11.3	144.7	0.760	98	89	+11	+10
122,245	175	61.0	20.5	133	0.91	121	14.5	12.5	181.2	0.734	123	109	+11	+12
122,795	171	68.1	21.5	146	0.89	130	15.5	12.4	192.2	0.759	130	108	+20	+20
116,975	178	46.0	19.0	134	0.90	121	14.4	12.9	185.8	0.721	126	106	+14	+19
88,146	158	69.0	24.5	129	0.88	114	13.8	12.2	168.2	0.766	114	97	+18	+18
86,058	150	56.3	21.5	120	0.89	107	14.2	11.3	160.5	0.747	109	86	+24	+26
138,647	171	76.4	20.0	145	0.90	130	14.8	12.8	189.5	0.765	128	111	+17	+15
U 403,644	162	61.5	20.5	127	0.90	114	15.6	10.8	168.5	0.753	114	98	+16	+16
U 396,443	174	61.2	19.5	150	0.90	135	15.1	13.8	204.0	0.735	138	108	+25	+28
116,994	167	60.5	19.5	139	0.90	125	14.8	12.4	183.5	0.757	125	102	+23	+23

For explanatory details, see Table V, page 696

TABLE III: MODERATELY ENLARGED HEARTS (+26% TO +50%)

X-ray or Unit No.	Height (cm.)	Weight (kg.)	AP Chest Diameter (cm.)	Planimeter Method			Diameter Method					Predicted Area (sq. cm.)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq. cm.)	Divergent Distortion Correction Factor	Net Area (sq. cm.)	Long Diameter (cm.)	Short Diameter (cm.)	L × S*	Agp/L × S†	Net Area (sq. cm.)			
128,932	183	79.0	24.5	187	0.88	165	17.8	13.7	244.0	0.766	165	122	+35	+35
124,687	158	58.0	18.5	135	0.90	121	15.3	11.7	179.0	0.754	121	93	+30	+30
122,442	163	55.4	19.0	160	0.90	144	17.0	11.8	200.5	0.797	136	97	+49	+40
82,864	160	68.6	20.0	149	0.90	134	15.6	13.1	204.2	0.729	138	99	+35	+39
79,986	156	55.0	18.0	128	0.90	115	14.6	11.2	163.5	0.782	111	90	+27	+23
79,656	150	59.0	20.0	135	0.89	120	14.5	12.4	180.0	0.750	122	87	+38	+40
80,695	176	89.0	25.5	184	0.88	162	18.0	13.4	241.0	0.766	163	120	+35	+36
78,542	172	60.8	19.0	163	0.90	147	16.1	12.7	204.5	0.797	139	106	+38	+31
78,490	154	60.0	20.0	139	0.89	124	14.9	12.3	183.4	0.755	124	90	+38	+38
79,652	150	70.0	25.5	131	0.88	115	15.0	11.3	169.5	0.773	115	90	+28	+28
80,892	174	62.8	22.0	165	0.89	147	16.7	13.0	217.0	0.760	147	109	+35	+35
78,993	177	92.0	27.5	183	0.87	159	18.2	12.1	220.0	0.831	150	121	+31	+24
77,898	156	75.0	22.5	138	0.89	124	14.3	12.5	179.0	0.771	121	97	+28	+25
73,621	154	47.0	20.0	131	0.90	118	14.3	11.6	166.0	0.788	113	86	+37	+31
78,559	163	61.0	22.0	151	0.89	134	15.2	12.9	196.0	0.770	133	98	+37	+36
80,449	167	56.6	19.5	143	0.90	129	14.8	13.3	197.0	0.725	133	101	+27	+32
122,115	170	79.6	21.0	162	0.89	144	15.2	13.7	204.1	0.793	141	111	+30	+27
85,638	144	68.0	29.0	136	0.87	118	14.4	12.4	178.5	0.761	121	85	+39	+42
U 399,620	160	67.8	24.0	149	0.88	131	15.4	12.3	189.5	0.785	128	98	+33	+31
98,196	160	58.0	24.0	155	0.88	136	17.5	11.6	203.0	0.763	138	95	+43	+45
U 397,113	180	91.7	26.5	183	0.88	161	16.9	14.7	248.2	0.737	169	124	+30	+36
U 414,029	173	61.5	23.0	171	0.89	152	16.7	13.6	227.0	0.753	154	107	+42	+43
53,777	158	53.6	18.0	136	0.90	122	14.5	11.8	171.0	0.795	116	92	+33	+26
U 420,711	152	51.0	19.5	127	0.88	114	14.8	11.0	162.8	0.780	110	86	+33	+28
U 399,938	157	63.2	25.0	143	0.88	126	15.4	12.7	195.5	0.731	133	94	+34	+41

For explanatory details, see Table V, page 696

TABLE IV: MARKEDLY ENLARGED HEARTS (+51% AND OVER)

X-ray or Unit No.	Height (cm.)	Weight (kg.)	AP Chest Diameter (cm.)	Planimeter Method			Diameter Method					Predicted Area (sq. cm.)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq. cm.)	Divergent Distortion Correction Factor	Net Area (sq. cm.)	Long Diameter (cm.)	Short Diameter (cm.)	L × S*	Agp/L × S†	Net Area (sq. cm.)			
130,401	169	58.0	20.0	225	0.90	202	19.1	16.2	309.7	0.726	210	103	+95	+103
129,020	154	81.4	27.5	194	0.87	169	18.0	13.8	248.2	0.787	169	98	+73	+73
130,221	172	84.4	25.5	213	0.88	187	18.8	15.3	287.8	0.746	195	115	+63	+69
117,839	163	62.0	21.0	189	0.89	168	17.6	14.0	246.0	0.768	167	98	+71	+70
122,709	171	90.5	27.5	212	0.87	184	18.2	15.6	284.0	0.746	192	116	+59	+65
120,189	172	71.5	22.0	223	0.89	198	19.9	15.1	300.6	0.809	204	110	+80	+85
120,433	166	62.0	21.0	203	0.89	181	19.0	14.2	270.0	0.752	183	101	+79	+81
121,459	166	70.8	23.0	240	0.89	214	20.5	16.6	340.0	0.706	230	105	+104	+119
119,288	150	70.0	24.0	186	0.89	166	18.4	13.6	250.0	0.744	170	90	+84	+88
77,410	173	72.5	24.0	211	0.88	186	18.8	14.9	280.0	0.754	190	111	+68	+70
79,479	147	51.8	22.0	157	0.89	140	16.3	11.9	194.0	0.809	132	82	+70	+62
79,565	160	65.0	24.0	170	0.88	150	17.1	12.2	208.2	0.816	141	97	+55	+45
119,229	173	79.7	25.5	243	0.88	204	19.9	15.3	304.2	0.799	207	114	+88	+81
122,395	159	56.0	22.0	268	0.89	239	19.7	18.4	362.2	0.740	246	93	+157	+162
88,718	153	46.5	21.0	153	0.89	136	14.8	14.0	207.5	0.737	141	85	+60	+65
118,601	178	86.2	26.0	314	0.88	276	22.0	17.3	380.7	0.824	258	120	+130	+115
77,649	170	57.2	19.0	204	0.90	184	19.2	13.7	263.5	0.775	178	104	+77	+71

For explanatory details, see Table V, page 696

TABLE V: UNDERSIZED HEARTS (−11% OR LESS)

X-ray or Unit No.	Height (cm.)	Weight (kg.)	AP Chest Diameter (cm.)	Planimeter Method			Diameter Method					Predicted Area (sq. cm.)	Percentage Variation from Normal Planimeter Method	Percentage Variation from Normal Diameter Method
				Gross Area (sq. cm.)	Divergent Distortion Correction Factor	Net Area (sq. cm.)	Long Diameter (cm.)	Short Diameter (cm.)	L × S*	Agp/L × S†	Net Area (sq. cm.)			
113,351	171	67.5	22.0	107	0.89	95	12.8	11.2	143.5	0.745	97	108	−12	−10
123,657	187	65.0	21.0	101	0.89	90	12.5	11.0	137.5	0 734	93	121	−26	−24
98,523	185	94.0	24.0	128	0.88	113	13.9	12.3	171.0	0.748	116	129	−13	−10
78,027	178	53.4	21.0	102	0.89	91	13.7	10.7	146.5	0.696	99	109	−16	−9
77,682	174	66.0	22.0	100	0.89	89	13.1	9.9	129.5	0.771	88	110	−19	−20
77,587	175	62.3	18.5	91	0.90	82	12.3	10.0	123.0	0.740	83	110	−25	−24
117,018	151	118.0	27.0	107	0.87	93	13.4	9.5	127.2	0.840	86	108	−15	−20
117,005	174	63.6	21.0	108	0.89	96	13.9	10.6	147.5	0.732	100	109	−12	−9
117,041	167	64.3	20.5	101	0.89	90	13.0	10.7	139.0	0.727	94	103	−13	−9
116,974	157	67.3	21.0	90	0.89	80	12.0	9.4	112.8	0.798	76	96	−17	−20

Explanation of Tables I–V

One hundred adult chest films were selected at random and the hearts were divided into five groups according to their size. All were measured independently by two methods: (1) a planimeter tracing of the complete cardiac silhouette; (2) the long and short diameter method employing the nomogram illustrated in the text.

When the planimeter method was used, the divergent distortion correction factor was figured individually for each patient. These correction factors formed the basis for calculating the average divergent distortion correction factor used in the construction of the nomogram.

The factor which, when multiplied by the product of the long and short diameter, would yield frontal plane area, was obtained from the formula Agp/L × S. The average factor used in making the nomogram was obtained by adding the correction factors calculated for each case and dividing by 100. This was 0.760. By the same method, this factor was calculated for each size of heart. The factors were as follows:

Normal hearts	±10%	(19 cases)	0.760
Slightly enlarged hearts	+11 to +25%	(29 cases)	0.752
Moderately enlarged hearts	+26 to +50%	(25 cases)	0.768
Markedly enlarged hearts	+51% and over	(17 cases)	0.767
Undersized hearts	−11% and under	(10 cases)	0.753

The variation in the correction factor for each category of heart size was not regarded as significant.

* Long diameter (in cm.) multiplied by short diameter (in cm.).

† Gross cardiac area measured by the planimeter divided by the product of the long and short diameters.

rule, are approximately perpendicular to each other, but no attempt is made to assure that relationship.[2]

In order to obtain the correction factor for the product of L × S, which would yield frontal plane area, it was necessary to draw the complete heart outline so that it could be traced with a planimeter. The product of L × S was compared with the planimeter measurement of the cardiac area to obtain a correction factor which would make them equal according to the formula:

$$\frac{\text{Planimeter measurement of cardiac area in sq. cm.}}{\text{Long diameter in cm.} \times \text{short diameter in cm.}} = \text{correction factor}$$

The 100 cases presented in the tables formed the basis for this comparison. The correction factor for all cases taken together was 0.760. Hence, the resulting equations will be

(1) $L \times S \times 0.760 = Ag$
(2) $L \times S \times 0.760 \times 0.89 = A$, *or*
$L \times S \times 0.676 = A$

where

L = long diameter of heart shadow
S = short diameter of heart shadow
Ag = gross frontal plane area
A = net frontal plane area

With the solution of the first two problems, it was comparatively easy to construct a single nomogram which would combine the equations for predicting normal size and measured size in such a way that percentage variation from normal could be read directly. In my nomogram (Fig. 2) the scales for long and short diameter are curved according to the formula of a parabola ($y = ax^2$) in order to make the scale for net frontal plane area arithmetic. The net frontal plane area scale would be logarithmic if the long and short diameter lines were vertical and straight. The scale for net frontal plane area must be arithmetic to compare with the arithmetic scale of predicted area obtained from the height and weight according to the formula of Hodges and Eyster (3), 0.87H + 0.34W − 63.8, where H = subject's height in cm. and W = weight in kg. The slope and position of the center scale for percentage variation from normal is obtained by connecting with a straight line the zero points of the scales for net and predicted frontal plane area.

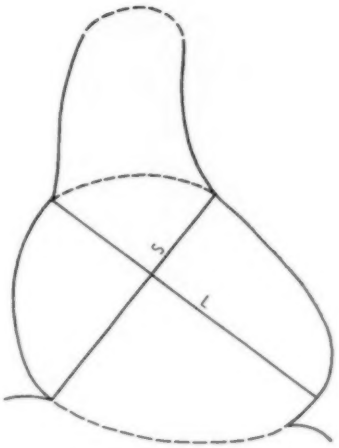

Fig. 1. Complete cardiac silhouette, showing how the long and short diameters are drawn. In actual practice the measurements are made directly on the chest film; since the heart shadow is not traced, the empiric upper and lower borders are omitted (broken lines).

The long diameter, L, is drawn from the right cardiovascular junction to the left apex. The short diameter, S, is drawn from the junction of left heart border and pulmonary conus to the right cardiophrenic angle.

Of course, this same combination of equations for measured and predicted area accounts for the curvature of the diameter scales in the chart of Ungerleider and Gubner (4). My chart differs from

[2] It is recognized that the point of maximum extension of the heart to the right occasionally appears to lie below the cardiohepatic angle, being lost in the shadow of the diaphragm. However, even in those few cases, it was surprising how little difference it made in the actual measurement of the short diameter when the lower empiric border was completed and a point selected which appeared to be the maximum extension of the heart to the right instead of the cardiophrenic angle. Usually the difference was less than one or two millimeters, sometimes none. If the diaphragm is high, either because of expiration or some pathologic condition, more of the heart shadow would be obscured and increase the error. No matter what method is used, the chances of error are great when much of the heart is hidden by the diaphragm. It would be best to avoid cardiac mensuration in those cases entirely.

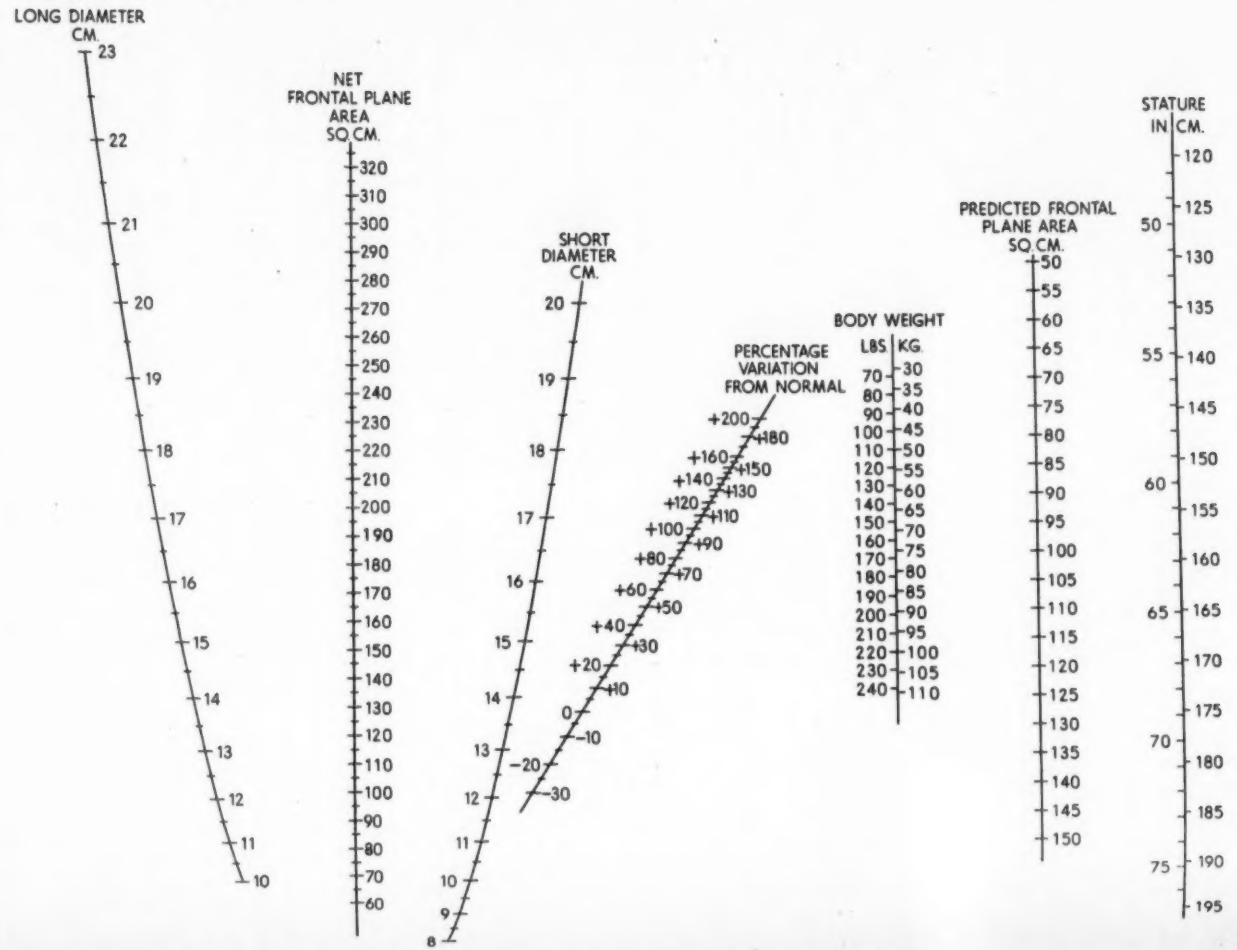

Fig. 2. Heart-size nomogram. For explanation, see foot of opposite page.

theirs chiefly in covering a wider range of heart size and providing a scale from which percentage variation from normal may be read directly.

In actual practice, we select the larger of the heart shadows in a set of stereoscopic chest films. However, seldom is there any significant difference in the heart size between the two films. Points from which the diameters are drawn are marked with a wax pencil on the chest film selected; the long and short diameters are measured with a transparent centimeter ruler. These values are transferred to the nomogram, the ruler is placed across the curved scales for long and short diameter, the net frontal plane area being read where the ruler intersects that scale. The ruler is then placed across the scales for body weight and stature; the predicted frontal plane area is read where the ruler intersects that scale. Finally, the ruler is so placed that it connects the values for net and predicted frontal plane area, the percentage variation from normal being read from the sloping center scale at the point intersected by the ruler. A heart which measures between ±10 per cent is considered within normal range.

In order to use the nomogram accurately, the following conditions should be met:

(1) The subject should be an adult seventeen or more years old; younger only if the stature exceeds 170 cm.

(2) The chest roentgenogram should be taken with the anterior surface of the patient's chest closest to the film.

(3) The target-film distance should be 72 inches.

SUMMARY

1. For the computation of heart size from chest roentgenograms without planimetry and without empirical completion of the upper and lower borders of the silhouette, the following equation is offered:

$$A = L \times S \times 0.676$$

where

A = the frontal plane area of the heart in sq. cm.
L = length in cm. of its long axis
S = length in cm. of its short axis

2. A seven-scale nomogram solves the equation and expresses heart size in percentage variation from normal.

NOTE: I would like to thank Dr. Paul C. Hodges, Chief of the Division of Roentgenology, University of Chicago, for his invaluable suggestions in the preparation of the manuscript, and Mr. Herman Rubin, Research Associate of the Cowles Commission for Research in Economics, for his assistance in construction of the nomogram.

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Fig. 2. Heart-size nomogram. For explanation, see foot of opposite page.

Explanation of Nomogram

The nomogram is applicable only to adults seventeen years old or older. It can be used for younger subjects only if the stature exceeds 170 cm. The chest roentgenogram should be taken with the anterior surface of the chest closest to the film, at a target-film distance of 72 inches.

The long and short diameters are measured directly on the chest film. The values are transferred to the nomogram, a straight edge ruler is placed across the scales for *long* and *short diameters* and the *net frontal plane area* read where the ruler intersects that scale. Next, the ruler is placed across the scales for *body weight* and *stature*, and the *predicted frontal plane area* is read where the ruler intersects that scale. Finally, the ruler is placed so that it connects the values for *net* and *predicted frontal plane area*, the *percentage variation from normal* being read on the sloping center scale at the point intersected by the ruler.

Photostatic copies of this nomogram, 14 × 17", may be obtained from the University of Chicago Bookstore, 5802 Ellis Avenue, Chicago 37, Illinois, at $1.50 each.

(For Spanish Summary, see following page)

SUMARIO

Medición del Corazón: Técnica Simplificada

Para computar el tamaño del corazón por las radiografías torácicas sin planimetría y sin completar empíricamente los bordes superior e inferior de la silueta, ofrécese la siguiente ecuación:

$$A = L \times S \times 0.676$$

en la que

A = área plana frontal del corazón en cm^2.
L = largo en cm. del eje largo
S = largo en cm. del eje corto

Un nomograma de siete escalas resuelve la ecuación y expresa el tamaño del corazón en variación porcentaria de lo normal.

The Retrogastric Space, Roentgenographically Considered[1]

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THIS STUDY WAS undertaken in an attempt to clarify certain aspects of the diagnosis of retrogastric masses by roentgenographic methods. In several routine cases of suspected retrogastric mass, when a clear-cut extrinsic pressure defect on the posterior border of the barium-filled stomach was not demonstrated, a great deal of speculation was aroused concerning the significance of the distance from the posterior stomach border to the anterior border of the adjacent vertebral bodies.

The literature is devoid of studies that might serve as a background for the theoretical "normal retrogastric space." Engel and Lysholm made exposures of patients in the prone-lateral position and demonstrated an impression on the posterior stomach wall which was interpreted as being caused by pancreatic pressure. In their cases without pancreatic disease, they stated that this impression was about the width of the adjacent vertebral body. Rendich, Poppel, and Cove quote Butler and Ritvo, as well as Rigler, as having stated that the stomach is displaced upward and forward by retrogastric masses. Volpe demonstrated identical compression of the antrum of the stomach by a hydatid cyst of the liver and by a retroperitoneal tumor, the latter "probably from the pancreas." Poppel and Marshak appreciated the fact that retrogastric masses might be expected to produce a different picture in hypersthenic and hyposthenic individuals. Holt quotes Case's observation that a cyst arising from the tail of the pancreas very frequently produces a smoothly rounded indentation in the greater curvature of the stomach and suggests that the association of such a defect, relatively high on the greater curvature, with anterior displacement of the stomach is strong evidence of pancreatic cyst. Shanks describes Twining's method of examination, which called for a lateral roentgenogram of the barium-filled stomach in the supine position.

In the studies cited above, all diagnoses were based on visible impressions upon the posterior gastric wall, and in none, with the exception of that of Engel and Lysholm, was reference made to measurable distance *per se*. In an effort to evaluate the importance of distance alone in the diagnosis of retrogastric masses, and hoping thus to find an aid in the absence of a demonstrable extrinsic pressure effect, we decided to use the left lateral erect exposure in all cases. It was felt that only in such a view would the stomach be seen free of pressure influences that might conceivably alter its true position. The universally accepted fact that the position of the stomach varies with the habitus of the individual was taken into consideration, and our patients were divided into habitus groups.

Ninety-seven unselected consecutive patients with complaints indicative of a high intrinsic gastro-intestinal lesion were examined in the left lateral erect position. The majority had histories suggestive of duodenal ulcer. In none was there any evidence, either objective or subjective, of retrogastric disease. Sixty-seven of the group (approximately 70 per cent) were sthenic in habitus, 16 (approximately 17 per cent) were hypersthenic, and 14 (approximately 13 per cent) were hyposthenic.

In all cases, the stomach was filled with barium in sufficient amount so that the extreme proximal cardia could be clearly visualized. In the hypersthenic and the sthenic group, three measurements were taken: first, from the posterior wall of the cardia to the anterior border of the vertebral body directly opposite; second, from

[1] Accepted for publication in April 1948.

the posterior wall of the pars media to the adjacent vertebral body; third, from the most distal portion of the posterior wall to the adjacent vertebral body. In the hyposthenic group, the anteroposterior diameter of the body of the third lumbar vertebra was also measured, for comparison with the retrogastric distances.

In the tabulation to follow, it will be noted that all designated measurements were made in millimeters. Zero (0) indicates that the posterior gastric wall is either in contact with the anterior border of the adjacent vertebral body or is actually superimposed posteriorly upon it. A dash (—) denotes cases of "transverse stomach" where the posterior wall, in its most distal portion, is at the same horizontal level as the posterior wall of the pars media. In Case 4 the examination was repeated and it is listed again as Case 31.

Sthenic Group

	Measurements (in mm.)		
	First (Cardiac)	Second (Mid Portion)	Third (Inferior)
1.	0	4	56
2.	36	74	125
3.	0	45	77
4.	0	15	23
5.	0	10	27
6.	0	21	44
7.	0	54	5
8.	27	139	120
9.	0	39	71
10.	0	77	88
11.	13	22	50
12.	7	36	41
13.	15	44	67
14.	0	8	44
15.	0	0	59
16.	0	23	44
17.	0	0	24
18.	0	25	31
19.	11	16	45
20.	16	41	53
21.	0	31	48
22.	14	48	66
23.	44	63	80
24.	14	45	53
25.	0	47	58
26.	44	42	26
27.	13	41	55
28.	18	50	69
29.	0	24	24
30.	8	27	68
31.*	0	29	46
32.	45	49	65
33.	0	24	30
34.	3	44	61
35.	2	44	87
36.	0	30	61
37.	0	50	69

Sthenic Group (Cont.)

	Measurements (in mm.)		
	First (Cardiac)	Second (Mid Portion)	Third (Inferior)
38.	0	0	38
39.	0	51	37
40.	0	41	84
41.	0	30	72
42.	23	50	108
43.	0	38	61
44.†	15	86	132
45.	0	32	65
46.	8	30	—‡
47.	11	52	76
48.	0	53	85
49.	10	25	38
50.	0	68	81
51.	0	69	81
52.	0	4	21
53.	31	101	120
54.	0	49	94
55.	0	46	92
56.	0	64	67
57.	7	71	72
58.	0	67	70
59.	11	87	128
60.	0	72	98
61.	0	57	71
62.	0	39	79
63.	0	22	74
64.	6	67	96
65.	0	40	—‡
66.	7	91	115
67.	0	41	69

Hypersthenic Group

	Cardiac	Mid Portion	Inferior
68.	16	15	48
69.	0	69	103
70.	44	79	100
71.	28	101	125
72.	0	78	62
73.	11	55	70
74.	9	84	72
75.	27	51	98
76.	8	64	73
77.	25	66	68
78.	26	53	64
79.	31	81	84
80.	0	69	83
81.	12	88	115
82.	12	69	90
83.	0	54	116

Hyposthenic Group

	Cardiac	Mid Portion	Inferior	Lumbar Spine
84.	0	32	62	50
85.	12	81	64	43
86.	0	27	77	36
87.	0	42	83	38
88.	0	12	16	41
89.	0	8	16	35
90.	0	9	23	49
91.	4	13	30	35
92.	0	6	34	40
93.	9	25	39	42
94.	0	15	38	44
95.	13	49	55	37
96.	4	7	55	43
97.	0	26	82	44

* Repeat examination of Case 4.
† Patient extremely obese.
‡ Transverse stomach.

RESULTS

As had been expected, all measurements were greater in the hypersthenic group than in the hyposthenic, indicating that the cardia was most often situated well anterior to the adjacent vertebral body and that the gastric axis was more anterior and generally more transverse than in the latter group. The measurements in the sthenic group showed a wide variation between the two extremes represented by the other groups and in some cases even paralleled these figures. Strangely enough, the only two "transverse stomachs" in the series were in sthenic patients.

In cases of the hyposthenic group, in which the third measurement (*i.e.*, from the most distal portion of the posterior wall to the adjacent vertebra) was the smallest, there was no definite correlation between this measurement and the anteroposterior diameter of the body of the third lumbar vertebra. For the most part the former figure was the greater.

In Case 4, in which, as mentioned above, the examination was repeated and recorded as Case 31, there was a noteworthy difference in the second and third measurements on the two occasions.

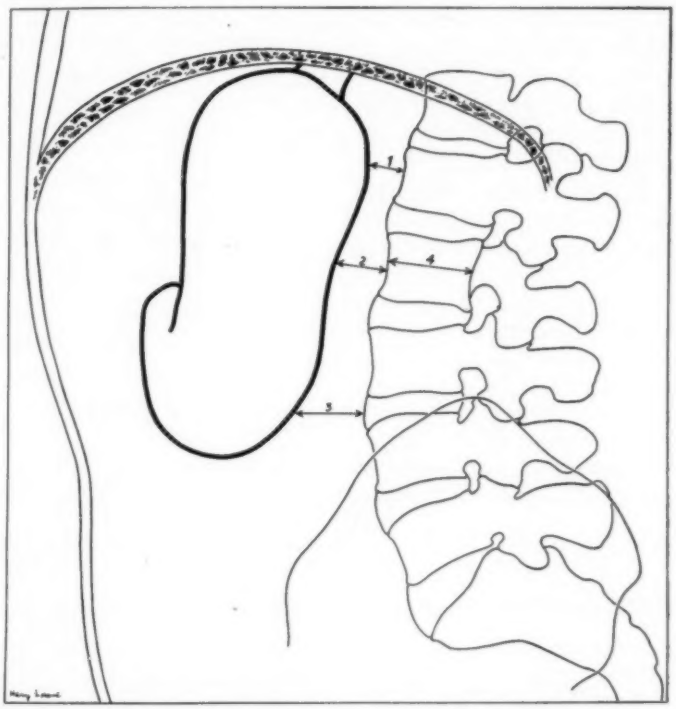

Fig. 1. Diagram showing measurements made of the retrogastric space. 1. From the posterior wall of the cardia to the anterior wall of the opposite vertebral body. 2. From the posterior wall of the pars media to the adjacent vertebral body. 3. From the most distal portion of the posterior gastric wall to the adjacent vertebra. The anteroposterior diameter of the body of the third lumbar vertebra (4) was also measured in hyposthenic patients for comparison with the retrogastric distances.

The most frequent impression upon the posterior gastric wall was due to distention of the large bowel in the region of the splenic flexure. This normal impression, which usually is seen in the proximal third of the stomach, must be differentiated from an impression of pathologic origin.

The most striking feature in this study is the complete inconsistency of the meas-

urements in the sthenic group. This observation gains in significance from the fact that the highest percentage of the population falls in this unpredictable group. Furthermore, as demonstrated by Case 4, the stomach is an extremely motile organ and capable of changing its configuration and its axis from moment to moment.

CONCLUSIONS

Roentgen studies of the barium-filled stomach in the left lateral erect position indicate that there is no absolute "yardstick" that can be applied to the retrogastric space for the diagnosis of retrogastric masses. No correlation existed between the retrogastric measurement and the anteroposterior diameter of a representative lumbar vertebral body.

The diagnosis of retrogastric masses depends entirely on the actual demonstration of extrinsic pressure defects in the posterior gastric wall. Since, under normal conditions, a distended splenic flexure may cause such a defect, this must be differentiated from pathological entities. Because the configuration of the stomach may change from moment to moment, the pressure defect must be proved constant before conclusions as to its significance are drawn.

NOTE: The authors wish to express their thanks to Dr. Lewis J. Friedman who, as Chief of the Department, extended his fullest cooperation.

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SUMARIO

El Espacio Retrogástrico Considerado Roentgenográficamente

Los estudios roentgenológicos del estómago lleno de bario en la posición erecta lateral izquierda indican que no hay escala absoluta que pueda aplicarse al espacio retrogástrico para el diagnóstico de las tumefacciones allí presentes. No se observó correlación alguna entre el resultado de la medición retrogástrica y el diámetro anteroposterior de un típico cuerpo vertebral de la porción lumbar.

El diagnóstico de las tumefacciones retrogástricas se basa en absoluto en el hallazgo real de nichos debidos a la presión extrínseca en la pared posterior del estómago. Como normalmente la distensión de la flexura esplénica puede ocasionar uno de esos nichos, hay que differenciarla, de las entidades patológicas. Dado que la configuración del estómago puede cambiar de momento en momento, hay que demostrar la constancia del nicho de compresión antes de sacar conclusiones en cuanto a su significado.

Mediastinal Emphysema Occurring During an Acute Paroxysm of Bronchial Asthma[1]

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MEDIASTINAL emphysema is being recognized with greater frequency, and its clinical and roentgen features are now well established. There are many exciting factors, bronchial asthma being one of the less frequent. Schwartz (1), in 1945, was able to collect from the literature 25 cases of mediastinal and subcutaneous emphysema occurring as a complication of bronchial asthma, and added one case of his own. Since that time (through 1946) two more cases have been reported (2, 3). A case is now being presented to record this phenomenon in the roentgen literature.

Macklin and Macklin's theory for the production of mediastinal emphysema is generally accepted. The mechanism of production is the same regardless of the exciting factor. In bronchial asthma the sequence of events is probably as follows:

A pressure gradient is created in the pulmonary alveoli due to the increased alveolar pressure and the decrease in caliber of the pulmonary vessels resulting from the prolonged expiratory phase of the lungs. As a result of this gradient, a so-called "marginal type" of alveolus ruptures and air escapes into the interstitial pulmonary tissue. (A "marginal type" of pulmonary alveolus is one in which the base of the alveolus borders on another structure such as a bronchus, bronchiole, blood vessel, connective tissue, or pleura, in contrast to the "partitional type," whose bases lie between alveoli.) Upon reaching the interstitial pulmonary tissue, the air spreads along the vascular sheaths to the mediastinum, where it results in mediastinal emphysema. After reaching the mediastinum the air may enter the soft tissues of the neck and chest wall, or may pass downward along the aorta and esophagus to reach the retroperitoneal space. Pneumothorax or pneumoperitoneum may complicate mediastinal emphysema.

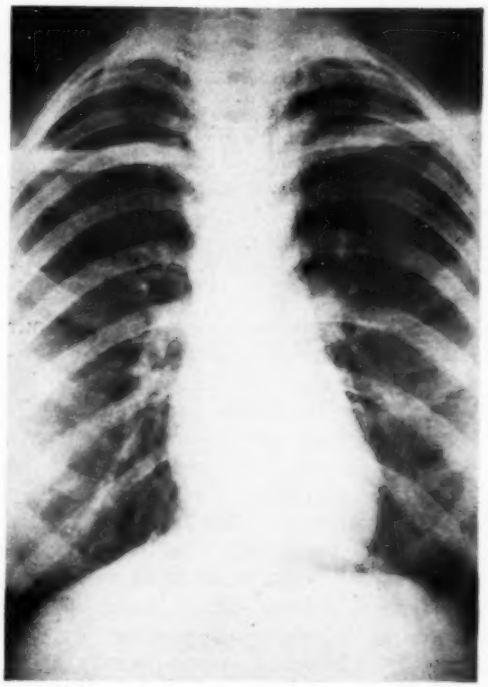

Fig. 1. Postero-anterior chest film made six hours after the onset of subcutaneous emphysema in the neck. The air in the mediastinum is clearly visible along the left heart border, extending from the diaphragm to the root of the neck. The subcutaneous emphysema in the neck was easily seen on the original film.

CASE REPORT

R. L., a white female, age 19, had been having acute paroxysms of bronchial asthma for several years. Early one morning, during an attack, she suddenly felt something "snap" in her upper chest, following which her neck began to swell. When seen at the Clinic about six hours later, she presented a moderate degree of subcutaneous emphysema of the neck and anterior chest wall. Auscultation of the chest revealed a peculiar sound in the region of the cardiac apex described by the clinician as

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"crunching" in character (Hamman's sign). In addition to dyspnea, the patient also complained of difficulty in swallowing solid foods. A chest film (Fig. 1) clearly showed the mediastinal collection of air, and the subcutaneous emphysema of the neck and superior chest wall. No film studies of the esophagus or abdomen were made. The patient was treated for her asthma and when she was seen two weeks later all signs and symptoms of the mediastinal emphysema had disappeared.

Certain features concerning this complication of bronchial asthma are worth enumerating.

1. The subcutaneous emphysema, usually in the base of the neck, is the symptom which first calls attention to the entity and results in further clinical and x-ray studies.

2. All the reported cases, including our own, terminated in recovery under conservative treatment. This probably indicates that the initial alveolar tear is small and closes over spontaneously and rapidly. As yet there has been no need for surgical treatment.

3. In many cases the appearance of subcutaneous emphysema results in sudden rapid improvement of clinical symptoms of asthma (dyspnea and cyanosis) because it acts as a release mechanism for pulmonary interstitial emphysema. (This was not true in our case). Prior to the release of the air into the mediastinum and thence into the subcutaneous tissues, it produces pressure on the blood vessels of the lungs, mediastinum, and heart (malignant interstitial emphysema of Macklin).

The diagnosis can be made both clinically and by x-ray examination. Presence of air in the subcutaneous tissues of the neck, plus the peculiar crunching or crackling sound heard on auscultation over the mediastinum is pathognomonic clinically. The x-ray findings include air in the subcutaneous tissue of the neck and chest, and demonstration of air in the mediastinum. The latter finding may be seen either on the postero-anterior or lateral view. In the lateral view the air is seen in the space between the heart and sternum. On the postero-anterior view the air is seen between the heart shadow and the mediastinal pleura (Fig. 1). With appropriate x-ray studies air in the retroperitoneal space could be demonstrated if present. The appearance would be similar to that recently reported (4) for retroperitoneal perforations of the duodenum. In these latter cases the air may extend superiorly into the mediastinum and neck.

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SUMARIO

Enfisema Mediastínico Durante un Acceso Agudo de Asma Bronquial

Comunícase un caso de enfisema del mediastino que ocurrió durante un acceso agudo de asma bronquial. Cabe explicar el fenómeno a base de una pendiente de mayor presión en los alvéolos pulmonares, con rotura de un alvéolo de "forma marginal" y difusión del aire escapado a lo largo de las vainas vasculares al mediastino. El paso del aire a los tejidos blandos del cuello y de la pared torácica produce un enfisema subcutáneo asociado, que suele ser el primer signo del estado. El diagnóstico se hace tanto clínica cuanto roentgenográficamente. En las radiografías laterales se observa el aire en el espacio entre el corazón y el esternón. En las posteroanteriores aparece entre la sombra cardíaca y la pleura mediastínica.

Studies of the Effect of Roentgen Rays on Healing of Wounds

III. Histological Changes in Skin Wounds in Rats Following Postoperative Irradiation with Very Small and Moderate Doses[1]

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THE EFFECT OF roentgen rays on the healing of skin incisions in rats has been the subject of previous experimental studies by Pohle and Ritchie (6, 7, 8). In spite of the importance of the clinical aspects, the subsequent literature contains only scanty, conflicting evidence concerning the effect of irradiation upon the healing of surgical wounds. This is particularly true with regard to the use of small doses of roentgen rays; a better understanding of this question should lead to a more satisfactory combined surgical and radiation procedure in the therapy of malignant disease.

While Pohle, Ritchie, and Wright (6) demonstrated that wound healing in rats is retarded by irradiation of the skin with 1,000 r, especially when given twenty-four hours after the incision, there is not complete agreement in the literature as to the effect when smaller doses are used. Fukase (4) found that following doses of about 400 r in rabbits the wounds contained less exudate than in the controls. Businco and Cardia (2) believed that 150 r had a stimulating effect on the healing process in dogs, although only four animals were used in their experiments. Nathanson (5), using gamma radiation, found that small doses accelerated the healing of incisions made in the abdominal skin in dogs.

Dobbs (3) conducted a series of experiments on rats, in which various amounts of radiation were given to skin wounds. On each of his animals he made two 4 cm. wounds, one of which he exposed to roentgen rays while the other served as a control. The tensile strength of the scars was tested after varying intervals, and in some cases histologic sections were obtained. The results showed that doses of 300 r given immediately after the wound was inflicted caused an increase in the tensile strength of the scar. Doses of about 1,000 r caused a decrease if given prior to the incision and no change if given afterward.

The present investigation has been undertaken in order to study the effect of roentgen rays applied in doses of 10, 25, 150, 300, 350, and 700 r upon the healing of wounds in rats. The technical factors were 100 kv., 5 ma., 2 mm. Al, 30 cm. focal skin distance, 2 × 2 cm. field, 45 r/min. (half-value layer in Al, 3.5 mm.).

METHOD AND EXPERIMENTS

The method employed was substantially the same as described in our earlier publications. Albino rats of the Sprague-Dawley strain, approximately 200 gm. in weight, were used. Under ether anesthesia a midline incision 4 cm. long was made on the back and a Michel clip applied at the midpoint of the wound. No further closure was attempted. The experimental work was divided into three groups as described below.

Group 1: Eighteen rats were used. In each of these one-half of the wound was irradiated immediately after the incision was made, and the other half was used as a control. These wounds were observed grossly for fourteen days, during which

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TABLE I: OBSERVATIONS ON ANIMALS WHOSE WOUNDS WERE IRRADIATED IMMEDIATELY

Dose →	10 r	25 r	150 r	300 r	700 r	Totals
Healing accelerated	1	1	0	2	0	4
Healing retarded	0	0	3	7	5	15
No effect	5	7	12	5	10	39
Animals discarded	2	0	0	1	0	3

TABLE II: OBSERVATION ON ANIMALS IN WHICH THE WOUND WAS IRRADIATED AFTER TWENTY-FOUR HOURS

Dose →	10 r	25 r	150 r	300 r	700 r	Totals
Healing accelerated	1	2	2	1	0	6
Healing retarded	0	1	3	5	5	14
No effect	6	5	9	8	8	36
Animals discarded	1	0	1	1	2	5

TABLE III: SUMMARY OF TABLES I AND II

Dose →	10 r	25 r	150 r	300 r	700 r	Totals
Healing accelerated	2	3	2	3	0	10
Healing retarded	0	1	6	12	10	29
No effect	11	12	21	13	18	75
Animals discarded	3	0	1	2	2	8

period a special effort was made to detect any difference between the two halves in regard to rapidity of healing.

The animals were divided as to dosage as follows: Rats 1–6, 150 r; rats 7–12, 350 r; rats 13–18, 700 r.

Group 2: Ninety rats were used. These were divided into 3 groups of 30 each, according to the dosage used. The first group received 150 r, applied to one-half of the wound, the second group 300 r, and the third group 700 r. In each group, 15 animals were treated immediately and 15 were treated twenty-four hours after the incision. Each group of 15 animals was finally divided into three groups of 5 each; these groups were sacrificed when the wounds were three, five, and seven days old, respectively. In approximately one-half of the animals, the cephalic portion of the wound was treated; in the rest, the caudal part was irradiated.

Group 3: A total of 32 rats was used. In 16 the lower half of the wound was exposed to 25 r; in the remaining 16 animals to 10 r. Irradiation was given either immediately or twenty-four hours after the incision had been made. The animals were sacrificed three and five days, respectively, after the incision.

In all animals the tissue about the wound was fixed in Bouin's solution. Blocks were cut from the treated and untreated part of each wound and embedded in paraffin, and sections were stained with hematoxylin and eosin.

RESULTS

Group 1: Although all wounds were examined daily, no consistent difference between irradiated and non-irradiated portions of the wound could be detected (Figs. 1A and B). Any differences which were found could easily be explained by differences in approximation of the wound margins or by infection. Almost all wounds were healed in twelve days, with scattered unhealed portions. The distribution of these foci of retarded healing was such as to exclude any relation between the irradiation and the speed of healing.

Group 2: In evaluating the results by histologic examination, the most important criterion was considered to be the amount of visible fibroblastic reaction in the margins of the wounds. The actual degree of closure could not always be taken as being commensurate with this reaction, since approximation of the margins was not uniform with the method used.

A summary of the results is presented in Tables I, II, and III, in which the animals are divided according to dosage, and each group is analyzed as to progress in healing of the irradiated portion of the wound as compared to the untreated part. It will be noted that the total number of animals evaluated is only 114, since 8 had to be discarded because of infection of the wounds or distortion which made evaluation impossible (Table III).

One fact was evident, however, which is not indicated in the tables. The degree of difference in healing between the two parts of the wounds is of some importance. It was found that the difference in favor of

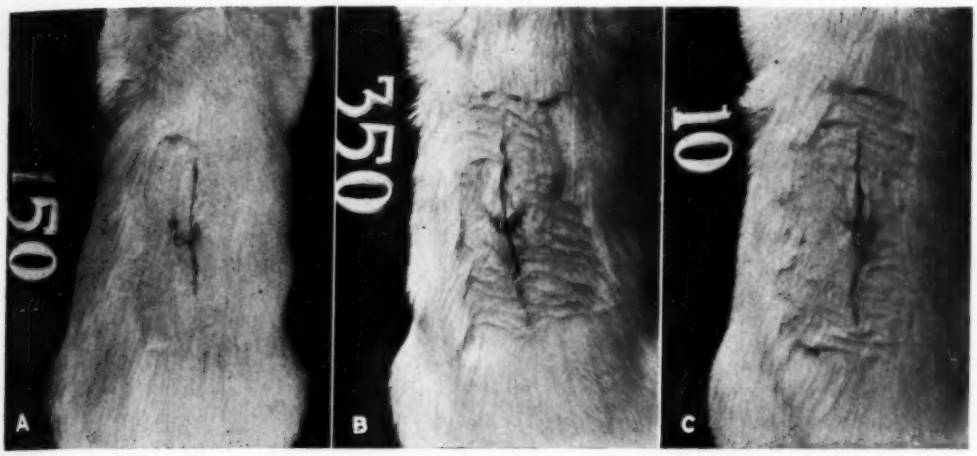

Fig. 1. Cranial half of wound irradiated immediately after the incision had been made. A. Exposure of 150 r. B. 350 r. C. 10 r. Macroscopically there is no difference in the appearance of the irradiated and non-irradiated portions of the wounds five days later.

the irradiated portion of the wound was never very pronounced, whereas that in favor of the control portion was in many cases considerable, especially with the higher doses.

Any retardation of healing in the irradiated portions was temporary; the number of rats in which such slowing was evident was at a maximum three days after incision, and by the seventh or eighth day was greatly reduced. This agrees with our former observations.

In many specimens the epithelium had bridged the defect completely, in spite of a minimum of fibroblastic activity in the underlying tissue; and in this respect no difference was observed between the irradiated and control specimens.

Group 3: As can be seen from the statistical tables, the irradiated wounds in some of the rats receiving 25 r and in those receiving 10 r tended to be slightly advanced in their healing as compared with the control portion of the wounds. While this was demonstrated histologically, we did not observe it macroscopically in our daily studies of the incisions (Fig. 1C). This advantage seemed in a few cases to be the result of greater fibroblastic growth, but in a larger number it appeared to be due to a smaller amount of acute inflammatory exudate than in the control section, with less fibrin to be replaced by scar tissue. In these instances the actual degree of fibroblastic activity appeared to be the same in the irradiated as in the control sections (Figs. 2–5).

DISCUSSION

The object of this study was to submit to histologic scrutiny the claim brought forth by various authors, namely, that small doses of x-rays stimulate or accelerate the healing of incisions on the skin. We have not been able to find any histologic evidence that such doses actually stimulate the healing process. The time interval between incision and irradiation, in our experiments either a few minutes or twenty-four hours, seemed to be of no significance.

Nathanson (5), on the other hand, using dogs, observed acceleration of healing only in those animals which were irradiated with small doses immediately after the incision had been made, while those irradiated twenty-four hours later did not show that effect. He leaves the question open whether this phenomenon is due to a depression of the inflammatory process, a stimulation of the connective-tissue cells, or to both.

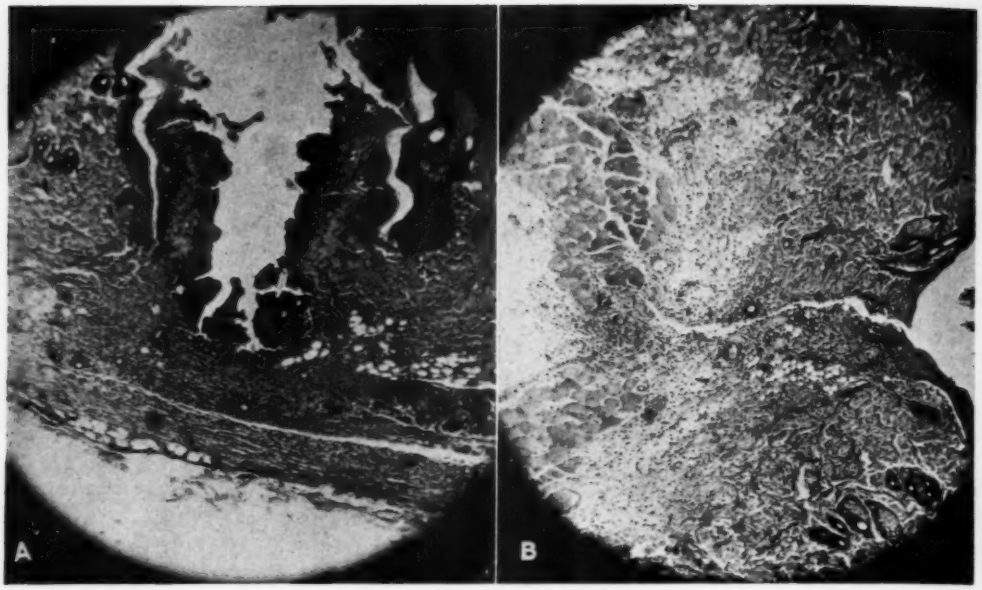

Fig. 2. Rat 8A, 25 r given immediately after incision. Wound is five days old. A. Control half of wound. B. Irradiated half, showing a more vigorous fibroblastic reaction and better union.

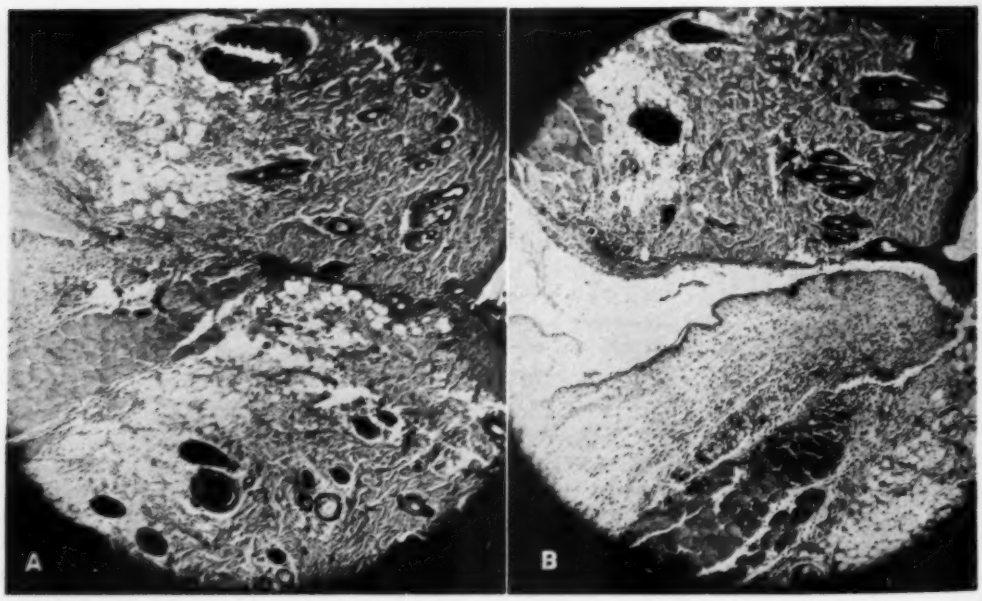

Fig. 3. Rat 10A, 25 r given twenty-four hours after incision. Wound is three days old. A. Control half of wound. B. Irradiated half. Almost no healing in A, with abundant inflammatory exudate. Only slightly greater fibroblastic reaction in B, but almost no exudate, and more advanced healing.

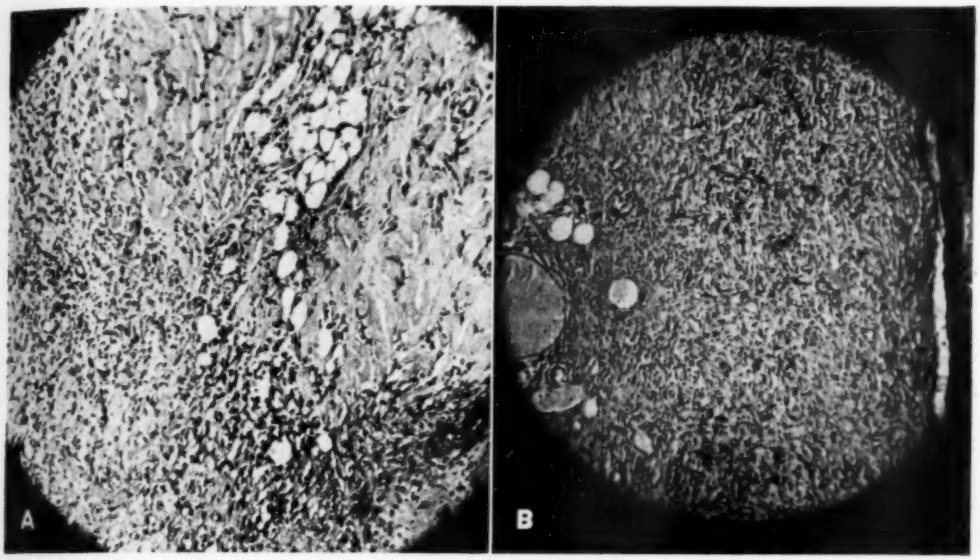

Fig. 4. Rat 6B, 10 r given immediately after incision. Wound is five days old. A. Control half of wound. B. Irradiated half, showing considerably narrower scar. Vigorous fibroblastic reaction in both.

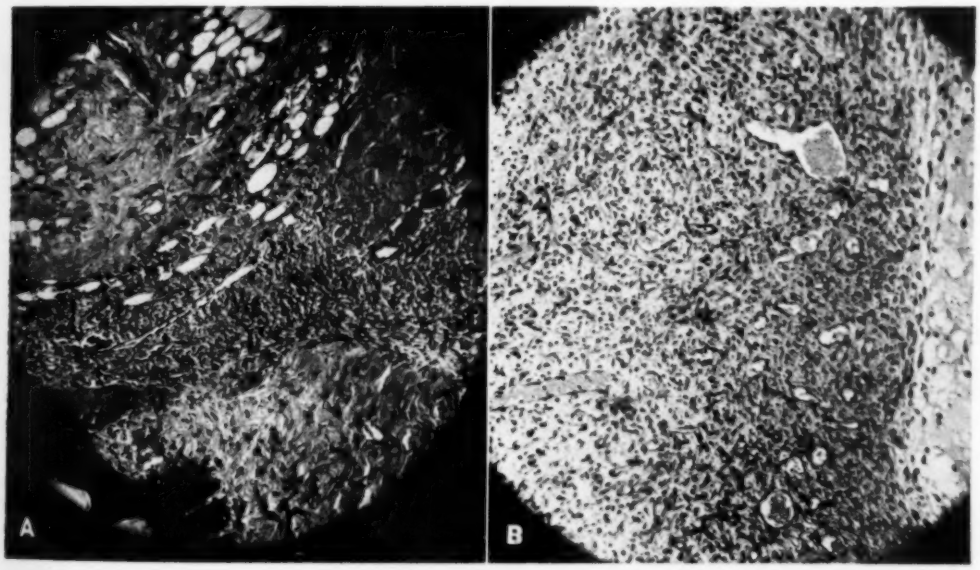

Fig. 5. Rat 14B, 10 r given twenty-four hours after incision. Wound is five days old. A. Control half of wound. B. Irradiated half. Scar in B is much less abundant.

The histologic study of the sections involved in the present study has brought to light some facts which may explain the conflicting opinions which exist with regard to the effect of low doses on the healing process. It was noted, for example, that the progress toward healing, particularly when the lower doses were used, depended greatly on the approximation of the margins of the wound. Specifically, in one

rat (150 r applied twenty-four hours after incision), both halves of the wound were well healed. Approximation, however, was slightly better in the irradiated half, and here the scar was much less conspicuous. The difference in healing sometimes seemed out of proportion to the difference in approximation. Such a situation suggested the possibility that the lower doses, while not affecting the actual production of fibroblasts, might cause a significant reduction in the amount of exudate in the wound. There would accordingly be less fibrin to be replaced by scar tissue and hence a smaller, less conspicuous scar. Such a change would take place, not by reason of actual stimulation of healing, but rather by a reduction in the amount of exudate which the healing process must replace. This hypothesis is in agreement with the work of Fukase (4) and of Buhtz (1). These authors, although differing somewhat as to details, agreed that small doses of roentgen rays administered immediately after the incision caused a decrease in the amount of exudate in the wound as early as five hours after the exposure.

Another problem to be solved is the actual functional effect of x-rays upon the fibroblasts. In doses which cause obvious growth changes in these cells the irradiation may be followed by the appearance of bizarre giant fibroblasts, abnormal cells which very probably are altered in their ability to produce collagen. Used in lower doses, which cause no histologic change detectable by ordinary means, x-rays may possibly create changes in the production of pre-collagenous and collagenous substance which affect materially the tensile strength of the wound. Further studies, both tinctorial and chemical, should be done in order to answer this question.

SUMMARY

1. The effect of roentgen rays in doses of 10, 25, 150, 300, 350, and 700 r (half-value layer in Al, 3.5 mm.) on the healing of skin incisions was studied macroscopically only in 18 and macroscopically and microscopically in 122 white rats.

2. Although all wounds were examined daily, no consistent difference in the healing time between irradiated and non-irradiated portions of the wound could be detected macroscopically.

3. Histologically, no true stimulative effect on the healing—even with the lowest doses used—could be found.

4. Any slight difference in the healing process in favor of the irradiated portion (small doses only) was considered to be due to a reduction in the amount of exudate, which in turn decreases the amount of fibrin to be replaced by scar tissue.

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SUMARIO

Estudios del Efecto de los Rayos X sobre la Cicatrización de las Heridas. III. Alteraciones Histológicas en las Heridas Cutáneas en las Ratas después de la Irradiación Postoperatoria con Dosis Muy Pequeñas y Moderadas

El efecto de los rayos X a dosis de 10, 25, 150, 300, 350 y 700 r (capa de hemireducción en aluminio = 3.5 mm.) sobre la cicatrización de las incisiones cutáneas fué estudiado macro y microscópicamente en 122 ratas blancas.

Aunque todas las heridas fueron examinadas a diario, no pudo distinguirse macroscópicamente ninguna diferencia constante en el tiempo de cicatrización entre las puertas irradiadas y las no irradiadas.

Histológicamente, no pudo descubrirse ningún verdadero efecto estimulante sobre la cicatrización—ni aun con las mínimas dosis utilizadas.

Toda leve diferencia en el proceso cicatrizante en pro de la porción irradiada (solamente con pequeñas dosis) fué considerada como debida a disminución en la cantidad de exudado, lo que a su vez hace bajar la cantidad de fibrina que debe ser reemplazada por tejido cicatricial.

Effects of Continuous Radiation on Chick Embryos and Developing Chicks[1]

I. Growth Rate, Gonads, and Bone

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THERE IS INCREASING demand for exact knowledge regarding the biological effects of continuous prolonged irradiation. The use of radioactive isotopes in medical therapy and exposure to radioactive substances in industry and scientific work (probably one of the greatest hazards today) presuppose such a knowledge, which actually is fragmentary and ill-defined. The following experiments were planned for the purpose of plotting out the effects, on different tissues, of large and small doses of radiation in relation to time intervals of exposure, and to establish the lethal threshold for cells of various types at different stages of development. Since very little work has been done with avian tissues, particularly in relation to the nucleated red blood cells, chicks were utilized.

MATERIALS AND METHODS

The agent chosen was the radioactive isotope P^{32}, and the subjects, chick embryos and growing chicks. The source of radiation, the isotope P^{32} (combined as KH_2PO_4 in an aqueous solution containing from 1,000 to 2,000 μc/c.c. of solution), has a half-life of fourteen days which insures sustained radiation.[2] P^{32} emits relatively soft beta rays, half of them being absorbed by 3 mm. of tissue and all of them by 8 mm. of tissue. The chick embryo was an ideal subject for insuring continuous irradiation with measured amounts of radioactive material, since this could be administered easily by intra-yolk injections and there was no loss through excretion during incubation. All of our eggs were taken from the same flock of White Leghorns over a three-month period. Incubation was carried out under the usual conditions, 38 to 39° C., 70 to 80 per cent relative humidity. The incubation period varied from twenty to twenty-one days.

To obtain an accurate and continuous picture of the radiation effects on the developing chick we used several groups of incubated eggs and chicks at various stages of development; each group was given a different dose of P^{32}. The amount of radiation administered and the ages of the subject at injection and when killed are given in Table I. Our experiments may be divided into three groups. In the first group are the embryos given a single injection. A sterile solution of P^{32}, as KH_2PO_4, was injected into the yolk from the fourth to the fourteenth day of incubation in amounts varying from 47.5 to 300 μc. In the second group are the chicks from one to thirty-seven days old given a single subcutaneous injection with approximately isotonic solutions of P^{32}, as KH_2PO_4, in amounts from 115 to 1,050 μc. The third group consists of those chicks receiving multiple injections, the limits of total dosage being 180 μc. and 3,696 μc. Chicks were killed by decapitation at intervals designed to give a continuous picture of the radiation effects. The lethal dosage for embryos and chicks varied with the age. Hatching percentages for injected eggs were as follows: 120 μc on fourth day of incubation, 15 per cent; 100 μc on eighth day, 30 per cent; 100 μc on fourteenth day, 50 per cent.

TABLE I: EMBRYOS AND CHICKS INJECTED WITH P^{32}
(Amount of P^{32} Injected, Age of Embryo or Chick at Time of Injection, and Age When Killed)
Embryos Injected (50)

[1] This work was done under Government Contract N5-ori-76 in the Laboratory of Pathology of the Harvard Cancer Commission. Accepted for publication in May 1948.

[2] P^{32} used in this work was supplied by Oak Ridge National Laboratories, Oak Ridge, Tenn.

TABLE I: EMBRYOS AND CHICKS INJECTED WITH P^{32}
(Amount of P^{32} Injected, Age of Embryo or Chick at Time of Injection, and Age When Killed)

Embryos Injected (50)

Amount of P^{32} →	47.5 μc.	120 μc.	100 μc.	100 μc.	180 μc.	200 μc.	200 μc.	300 μc.
Age at Time of Injection →	5th Day of Incubation	4th Day of Incubation	8th Day of Incubation	14th Day of Incubation	4th Day of Incubation	8th Day of Incubation	14th Day of Incubation	14th Day of Incubation
Ages of birds and embryos taken for histologic study	(2)* 1-day chick 2-day chick 4-day chick	9-day embryo 13-day embryo 15-day embryo 18-day embryo Hatching chick 2-day chick* 22-day chick 51-day chick	(2)* 1-day chick 3-day chick 54-day chick 55-day chick 56-day chick	16-day embryo 18-day embryo 19-day embryo (2)* 20-day embryo Hatching chick 3-day chick 7-day chick 11-day chick 15-day chick	13-day embryo 15-day embryo 18-day embryo Hatching chick	(3)* 1-day chick (2)* 15-day chick†	17-day embryo 18-day embryo 1-day chick 3-day chick 5-day chick 7-day chick 9-day chick 11-day chick 13-day chick 15-day chick	4-day chick (2)* 7-day chick†

Chicks Receiving Single Injection (18)

Amount of P^{32} →	170 μc	180 μc	235 μc	300 μc	760 μc	1,050 μc	1,050 μc previously 100 μc 8th day incubation	500 μc	700 μc	115 μc
Age at Time of Injection →	1-day chick	4-day chick	6-day chick	20-day chick	29-day chick	37-day chick	37-day chick	24-day chick	24-day chick	22-day chick
Ages of birds taken for histologic study	2-day chick	6-day chick	20-day chick (2)* 57-day chick	43-day chick 51-day chick	52-day chick 55-day chick 60-day chick	57-day chick 60-day chick	55-day chick 59-day chick	35-day chick	35-day chick	(2)* 30-day chick

Chicks Receiving Multiple Injections (6)

Amount of P^{32} and Time of Injection						
	100 μc, 20-day chick 80 μc, 22-day chick	100 μc, 20-day chick 80 μc, 22-day chick 100 μc, 24-day chick	700 μc, 24-day chick 400 μc, 27-day chick	518 μc, 21-day chick 600 μc, 25-day chick	420 μc, 26-day chick 300 μc, 32-day chick 1,000 μc, 45-day chick 670 μc, 54-day chick 280 μc, 65-day chick	600 μc, 31-day chick 670 μc, 40-day chick 390 μc, 51-day chick 1,036 μc, 66-day chick 1,000 μc, 70-day chick
P^{32} Total	180 μc	280 μc	1,100 μc	1,118 μc	2,670 μc	3,696 μc
Age of birds taken for histologic study	30-day chick	30-day chick	34-day chick	38-day chick†	75-day chick	79-day chick†

* Numbers in parentheses to left of age of chicks indicate more than one chick killed on that day.
† Indicates chicks that died as a result of radiation.

TABLE II: TISSUE ACTIVITY

No. of Chick	Amount of P^{32} Injected	Age at Injection	Time Between Injection and P^{32} Tissue Activity Determination	Bone	Liver	Muscle
376	120 μc	4th day incubation	40 days	1.79	0.15	0.159
590	200 μc	8th day incubation	29 days	18.36	0.88	0.84
592	200 μc	8th day incubation	29 days	15.00	0.77	0.71
617	235 μc	6 days after hatching	14 days	13.2	0.64	0.52
611	235 μc	6 days after hatching	51 days	0.021	0.0017	0.0017
612	235 μc	6 days after hatching	51 days	0.0208	0.0023	0.0025
544	300 μc	19 days after hatching	24 days	0.2	0.02	0.015
604	760 μc	29 days after hatching	24 days	0.31	0.026	0.026
608	760 μc	29 days after hatching	26 days	0.16	0.014	0.014

This embryo mortality was, however, not entirely due to radiation. Injection of non-radioactive KH_2PO_4 in amounts equal to the radioactive doses used accounted for about half the mortality. Hatchability of non-irradiated eggs was 75 per cent.

Blood counts were made according to the method described by Carl Olson, Jr. (1). In this method the red blood cells and granulocytes are counted directly in a counting chamber with the use of phloxine as a differential stain. A differential white count is made on a smear, and the lymphocyte count is calculated. This method is reasonably accurate in all instances except in the calculation of the lymphocyte count when the granulocyte count is near zero and the differential count is nearly 100 per cent lymphocytes. Since these lymphocyte values are subject to error, they are omitted.

The most important and direct radiation effects were on bone marrow, peripheral blood, the lymphoid system, bone, cartilage, and gonads. The radiation effects and associated changes of these organs will be discussed more fully below.

So far as we know, only two papers have dealt with the effects of P^{32} irradiation on tissues. A brief report of four autopsies of patients who received P^{32} in the treatment of leukemia is given by Lawrence, Scott, and Tuttle (3). Platt (4) examined the tissues from a sizeable series of autopsies of patients treated with P^{32}. He described changes in skin, esophagus, gastro-intestinal tract, liver, kidneys, ureters, bladder, pancreas, heart, lungs, and skeletal muscles, attributed to radiation, which were not seen in our chicks. There is a discrepancy between his observations and ours which cannot be explained altogether by the difference in experimental conditions. The range of dosage of radioactivity per unit weight used by us was about six times higher than the therapeutic dosage in Platt's series, but the intervals after irradiation at which our observations were made were much shorter.

OBSERVATIONS

1. Location of P^{32}: The first set of observations was made on the location and movement of P^{32} after injections into the incubated eggs (2). It is sufficient here to note that 90 per cent of the P^{32} injected into the yolk of an egg on the fifth day of incubation was taken up by the developing embryo and that at hatching this was shown by autoradiograms (Fig. 2) to be concentrated principally in the bones.

The amounts of P^{32} retained by the various tissues in chicks injected both during incubation and after hatching were traced by radioactive measurements (Table II) and by autoradiograms.[3] Excretory loss was not measured. As in the embryo,

[3] The authors wish to express their appreciation to Mrs. Kathryn Haley and Mr. Russe[illegible] Cowing of the New England Deaconess Hospital for invaluable technical assistance in making autoradiograms and in measurement of radioactivity in chick tissue.

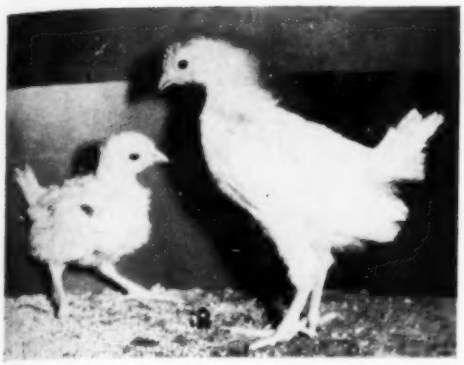
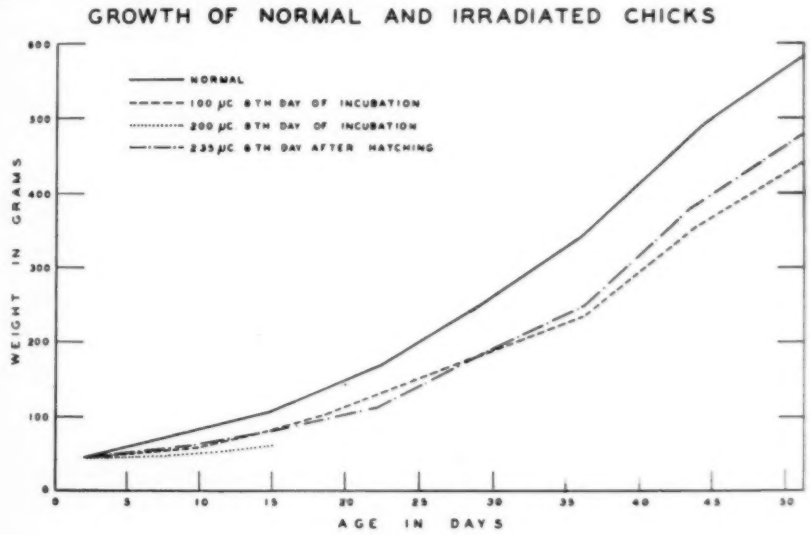


Fig. 1. Comparison of irradiated and non-irradiated twenty-three-day male chicks. The administration of 120 μc P^{32} to the smaller chick on the fourth day of incubation caused dwarfing and inhibited secondary sex characteristics, as evidenced by hypoplasia of the comb.

the ability of the bones to pick up the injected phosphate.

Since the beta radiations of P^{32} penetrate only 8 mm. of tissue, a large part of the ionizing effect was spent in or near the bones. The other tissues of the body, therefore, received relatively slight but fairly uniform irradiation only in the first few days after injection.

2. Effect of Radiation on Growth: Radiation retarded growth of male and female birds alike. This inhibition did not affect one part more than another. There was no gross deformity of structure, but the suppression of growth resulted in a miniature of the normal bird.[4] This is illus-



Graph 1.

P^{32} was progressively concentrated in the bones. Forty-eight hours after subcutaneous injection there was only slightly greater deposition in bones than in other tissues, but two weeks later the concentration in bone was twenty times greater than that in the soft tissues. In general, this concentration of retained P^{32} in the bones of our chicks was higher than that which has been reported in rodents and man (4–6). Part of this difference may have been due to the rapid growth of our immature chicks, which would increase

trated in Figure 1, where a male chick injected with 120 μc on the fourth day of incubation is compared twenty-three days after hatching with a normal male chick of the same age. The effectiveness of radiation in retarding growth depended on the age of the subject. While 200 μc was much more effective than 100 μc when given on the eighth day of incubation,

[4] Certain secondary sex changes to be discussed later are contrary to this generalization. These changes are probably not due primarily to radiation effects but secondarily to changes in the gonads caused by radiation.

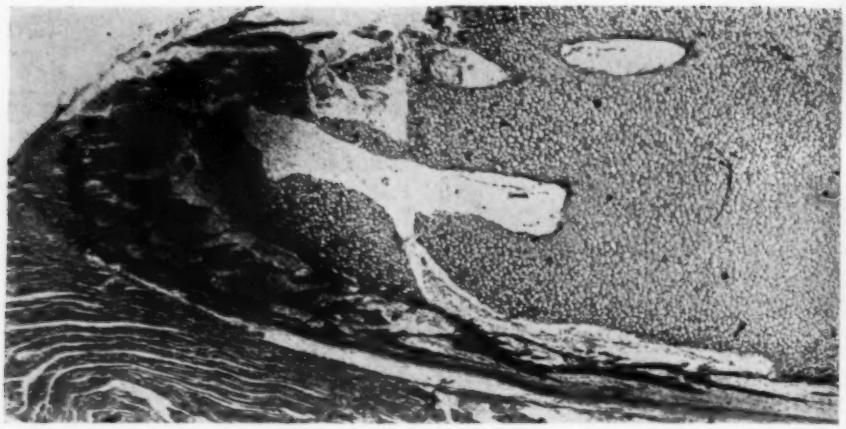


Fig. 2. Autoradiogram of chick femur at hatching. The chick had been given 100 μc P^{32} on the fourteenth day of incubation. Section is unstained. The black zone in region of calcified bone shows presence of radioactivity. Muscle and cartilage show little or no radioactivity. ×33

235 μc given six days after hatching had little more effect than 100 μc on the eighth day of incubation. Growth curves for treated chicks are compared with normal curves on Graph I.

3. Effect of Radiation on Gonads: In the chick, as well as in the chick embryo, the gonads of both sexes occupy approximately the same anatomical position and are roughly equal in size. Thus the comparative sensitivity of ovary and testis to radiation from P^{32} could be easily determined. We were able to compare the development of the gonads under normal and experimental conditions up to two months after hatching.

Because the effect of irradiation on the gonads, and more specifically on the germ cells, varied according to the stage of development, it may be helpful to review briefly the development of the chick gonads. They appear on the medial surface of the mesonephros. In the undifferentiated stage they are made up of closely packed germ cells and undifferentiated epithelial cells (both of which are undergoing mitosis) and are covered by a layer of cuboidal to columnar cells. Distinguishing characteristics appear on the seventh day. In the gonad destined to become a testis, epithelial tubules containing primitive germ cells develop in the medulla, while the cortex begins to atrophy. During the second week of embryonic life, the tubules are well formed, the ratio of spermatogenic to epithelial cells being about 1 to 5 or 10. Interstitial cells are first recognized on the ninth day. The ovary is recognized on the seventh day by closely packed primitive ova undergoing mitosis and expanding the cortex. Stromal proliferation gradually isolates each ovum. In the five-day-old chick, isolated ova are scattered singly in newly developed stroma, and most of them are surrounded by follicular cells identical to and in some instances continuous with the surface epithelium. From then on, the ova grow by intracellular accumulations; at two months of age, the largest are 500 μ in diameter. This description applies only to the left ovary, the right having atrophied during the latter half of incubation.

Testis: The primary effect of radiation is destruction of the germ cells with little or no immediate change visible in the other elements. Only after a period of several weeks of irradiation were the irradiated testes noticeably smaller than normal. At this time they showed retarded tubular development. Because these somatic testicular changes were of almost equal degree regardless of amount of radiation, and persisted after significant

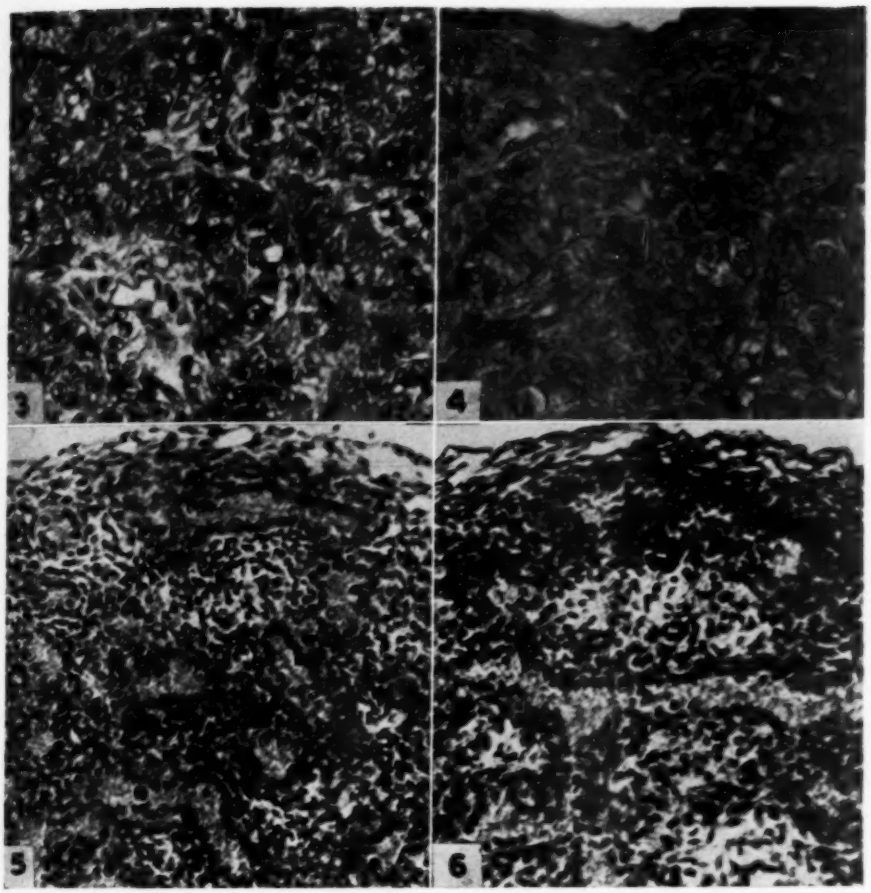


Fig. 3. Testis of normal eight-day embryo. Note tubule formation and numerous large germ cell nuclei.

Fig. 4. Testis of nine-day embryo injected with 120 μc on fourth day of incubation. Note absence of large germ cells and reduced number of tubules as compared with normal in Figure 3. The interstitial elements also appear more condensed than normal. Figs. 3 and 4 ×600

Fig. 5. Testis of normal hatching chick. Tubules are lined by regular columnar epithelium and contain many germ cells with large pale nuclei. Note germ cell in mitosis near lower left corner.

Fig. 6. Testis of hatching chick which received 100 μc on eighth day of incubation. Tae only apparent abnormality is complete lack of germ cells in the tubules. Compare with normal as seen in Figure 5. Figs. 5 and 6 ×300

amounts of radiation remained, it seemed possible they were secondary to loss of germ cells rather than the direct result of radiation injury.

The amounts of P^{32} injected into embryos varied from 47.5 μc on the fifth day of incubation to 300 μc on the fourteenth day. Despite these wide variations, the testes of chicks at hatching all showed essentially the same changes (Fig. 6); germ cells were entirely destroyed while other elements were unharmed. This implies a high degree of sensitivity of the germinal epithelium. Only the embryos injected very early in incubation, the fourth day, showed, in addition to loss of germ cells, a slight decrease in tubule formation during incubation (Fig. 4).

With lapse of time, testes of irradiated embryos showed more marked gross abnormality. In birds which were moribund fourteen, sixteen, and eighteen days after

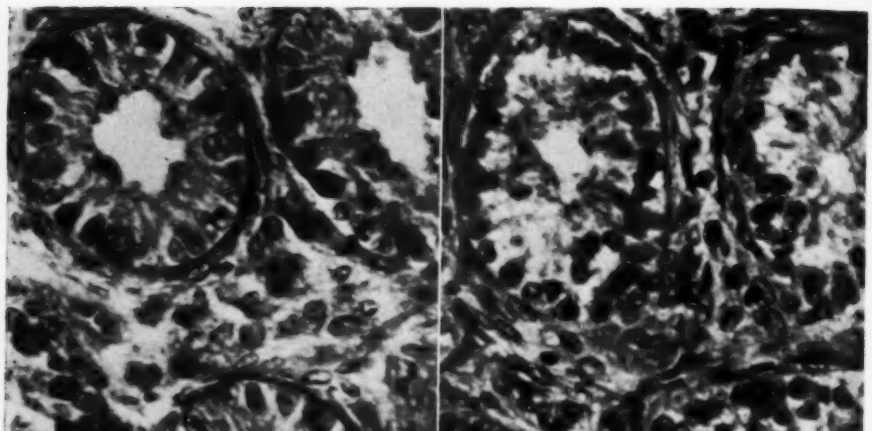


Fig. 7. Testicular tubules from normal seven-week chick. Tubules are lined by columnar epithelium and contain germ cells with large nuclei and dark cytoplasm. Interstitial tissue is composed of loosely arranged connective-tissue cells. ×600

Fig. 8. Testicular tubules from fifty-four-day chick given 100 μc on eighth day of incubation. Germ cells are absent, tubules have small lumens, and lining cells are markedly vacuolated. Interstitial tissue is slightly more condensed than normal (Fig. 7), and the nuclei are smaller. ×600

injection of 200 μc on the fourteenth day of incubation, the only gross testicular abnormality was a slight diminution in size. The histologic changes consisted of loss of germinal epithelium and some tubular atrophy. The testes were one-half normal diameter thirty-nine days after injection of a four-day embryo with 120 μc. The tubules were narrowed, and there was loss of spermatogenic cells, but the normal columnar epithelium and the basement membrane were unaltered. The interstitial cells were also normal in structure. The stroma appeared slightly condensed, suggesting atrophy. The most advanced changes were noted from six to seven weeks after administering 100 μc. to eight-day embryos (Fig. 8): the testes were one-third to one-half the normal diameter; the tubules were atrophic, the lumen small and void of spermatogenic cells; the columnar lining cells showed cytoplasmic vacuoles of doubtful significance; the basement membrane was less distinct than normal; the stroma appeared slightly condensed, but the interstitial cells were normal in structure and distribution.

In the chicks injected subcutaneously with P^{32} after hatching, the same destruction of spermatogenic cells with similar minor changes in other testicular elements was seen. Forty-eight hours after injection of 180 μc, the testes of a four-day male chick had lost nearly all of the spermatogenic cells; only a few degenerating forms were still visible. The tubular epithelium and interstitial cells showed some hydropic change, and there was moderate interstitial edema, changes characteristic of acute radiation reaction. Observations from four to forty-eight days after injection revealed no edema or hydropic changes. The loss of spermatogenic cells was constant and was the only testicular change apparent during the first week after injection. Several weeks later, atrophy of the testicle became apparent and the changes were the same as those seen in the irradiated embryos examined a number of weeks after hatching.

In none of the male birds irradiated during incubation did secondary sex characteristics develop during the sixty-day observation period. At two weeks the

comb of a normal male chick distinguishes it from a female, and by four weeks the comb is very prominent. At eight weeks the normal male and female comb, wattles, and body structure are distinct and characteristic. These male birds irradiated during incubation had no large red combs or wattles, and their body structure was not definitely male. An early example of this change is seen in Figure 1.

Discussion: The primitive spermatogenic cells of the testes of embryos and chicks of all ages were completely destroyed by all doses of radiation used in these procedures, but significant primary radiation changes in the other testicular elements were not found even after the largest doses. Since our smallest dose, 47.5 μc on the fifth day of incubation, destroyed the spermatogenic cells, and 180 μc on the fourth day caused no primary injury to the somatic testicular cells, it appears that the spermatogenic cells are at least five times as radiosensitive as the somatic testicular cells.

Several weeks after the primary radiation destruction of the germ cells, retarded tubular development and testicular growth became evident. These changes were of almost constant magnitude, regardless of amount of radiation, and they persisted long after any significant amount of radiation remained. These facts suggest that the later changes may be a secondary effect caused by loss of primitive germ cells rather than by actual radiation injury to the remaining structures.

The absence of development of secondary sex characteristics in the male birds irradiated during incubation suggests either a decrease in or an abnormality of the androgen secreted.

Ovary: The germ cells of the ovary are extremely radiosensitive, as are those of the testis. The other elements show only minimal changes, which may not be attributed to radiation. The degree of injury, however, unlike that of the testis, is determined by the amount of radiation and the age at which the ovary is irradiated. In the testis the effect was the same at the time of hatching whether

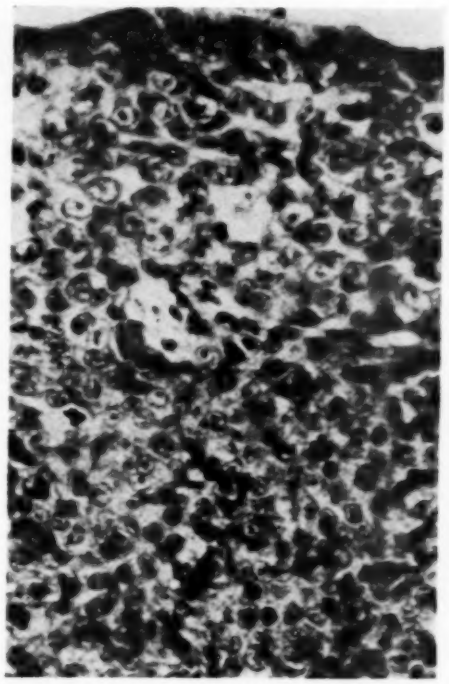


Fig. 9. Section through cortex of ovary from normal fifteen-day embryo. The cortex occupies approximately the upper half of the picture and is filled with large germ cells with large, pale nuclei. The surface is covered with several layers of small cuboidal epithelial cells. The medulla is made up of rather uniform cells, closely packed. ×600

47.5 or 300 μc were injected into embryos. The ovaries, on the other hand, showed a definite variation, indicating that the older germ cells were distinctly more resistant. A dose of 47.5 μc on the fifth day of incubation destroyed all ova and caused a moderate ovarian atrophy at hatching time sixteen days later. In a four-day embryo 120 μc caused nearly complete destruction of ova nine days later (Fig. 11). This damage was permanent. Fifty-one days after hatching, the ovaries were atrophic, no ova could be found, only occasional clusters of follicular epithelium being present. The medulla was diminished in size, but structurally normal. On the other hand, 100 μc on the fourteenth day of incubation resulted in only a partial depletion of ova four days after injection (Fig. 10); one-third to one-fourth the

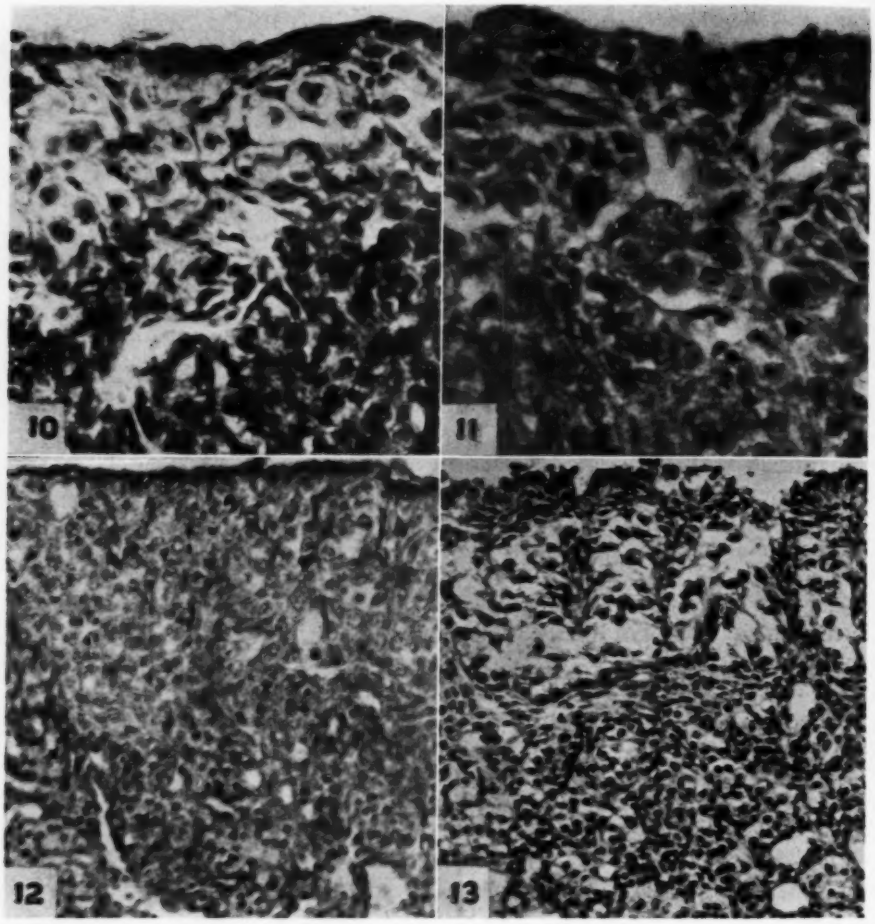


Fig. 10. Cortex of ovary of eighteen-day embryo which received 100 μc on fourteenth day of incubation. Only a few germ cells remain, and these show hydropic changes. The cortex is about one-half as thick as that of a normal fifteen-day embryo (see Fig. 9). The medulla does not appear to have suffered radiation injury. ×600

Fig. 11. Ovarian cortex of thirteen-day embryo given 120 μc on fourth day of incubation. The cortex contains no ova but shows some fibrosis, with clustering of what appear to be follicular epithelial cells. The medulla is slightly less cellular than normal but otherwise not unusual. ×600

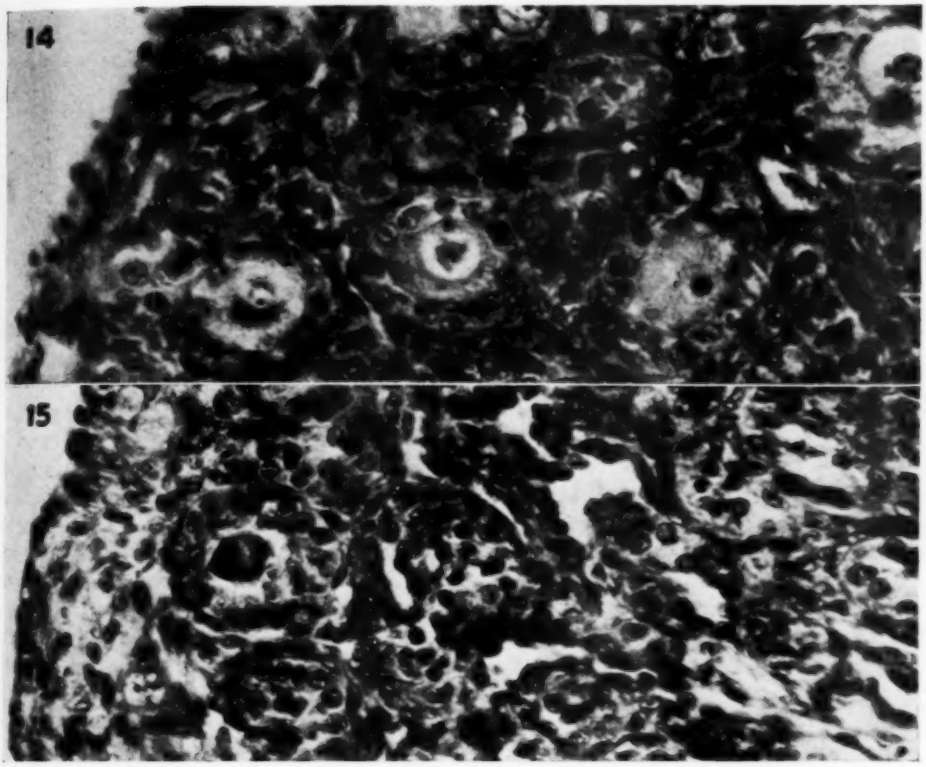
Fig. 12. Section through ovarian cortex of normal three-day chick. The cortex is thicker and contains more ova than the fifteen-day embryo in Figure 9. There are numerous connective-tissue septa growing into the cortex. At the bottom of the picture some of the numerous endothelial-lined spaces near the ovarian hilum are seen. ×300

Fig. 13. Ovary of two-day chick given 170 μc twenty-four hours previously. Cortex is narrow (compare with Fig. 12). Many ova have been destroyed and those remaining show hydropic change and pyknotic nuclei. ×300

normal number of ova still remained thirty three days later.

On the fourth day of incubation 180 μc reduced the ovarian cortices of embryos examined eleven and fourteen days later to narrow zones of loose connective tissue without germinal elements. In these ovaries there was also slight to moderate medullary hypoplasia.

On the fourteenth day of incubation, 200 μc caused a more marked destruction of ova than injection of 100 μc on the same day, but still all ova were not destroyed as with smaller doses given early in incuba-



Figs. 14–15. Portion of ovarian cortex with numerous ova from normal fifteen-day chick is shown in Figure 14. Figure 15 shows ovary of moribund fifteen-day chick given 200 μc on fourteenth day of incubation. Note thin cortex of latter, occupying only about one-fourth of the field and containing a single ovum. ×600

tion. Three days after injection, one-half to two-thirds of the cortical germinal cells were destroyed and mitotic activity was reduced, with resultant thinning of the cortex. There was as yet little apparent change in the medulla. Ovaries of these embryos examined ten and twelve days after injection were small and had cortices containing about one-third the normal number of germinal cells. The medullae were correspondingly small but histologically negative. These birds died from severe anemia within fifteen days after hatching. The ovaries at death contained an estimated one-tenth to one-twentieth of the normal number of ova with little mitotic activity in the germinal epithelium. The medullae were markedly hypoplastic. Such an irradiated ovary and a normal one are compared in Figs. 14 and 15.

Repeated subcutaneous injections of P^{32} in birds after hatching had a destructive effect on young ova and an inhibitory effect on maturing ova proportionate to the amount of P^{32} given, but radiation heavy enough to cause fatal anemia did not destroy all ova. The early effect of such injection on young ova was clearly seen in a chick one day old injected with 170 μc P^{32} and killed twenty-four hours later (Fig. 13). The cortex had lost approximately one-half to two-thirds of its primitive germ and epithelial cells and was in some places collapsed and in others edematous. The remaining ova and epithelial cells varied in degree of hydropic change, pyknosis of nuclei, and irregularity of cellular outline. The medulla was not obviously affected by this twenty-four-hour exposure. From observation on birds

living several weeks following irradiation, it was seen that some of these spared ova would grow but would be smaller than normal. The medullae were retarded in proportion to the injury to the ova. The effect in the older birds was to inhibit growth of large ova and destroy at least part of the very young ova. In no case did we see the cellular response to free lipoid which one would expect if the more mature ova with much stored lipoid were destroyed.

Discussion: In the ovary the primitive ovum was the most radiosensitive element. However, the age of the ova was an important factor in determining response to radiation. All injections of P^{32} during the first eight days of incubation, the smallest being 47.5 μc, destroyed the ova. All injections made on and after the fourteenth day of incubation, in spite of delivering more radiation to the ovary than the earlier injections, failed to destroy all ova. For example, 200 μc on the fourteenth day of incubation delivered, during the remainder of incubation, approximately twice as much radiation as came from 47.5 μc given on the fifth day of incubation; yet the larger dose failed to destroy all the ova as the smaller dose had. Another example was seen in chicks injected with fatal and near-fatal amounts of P^{32} after hatching. Only partial destruction of the most immature ova and temporary inhibition of the developing ova occurred in these older birds, in contrast to the complete destruction of all ova in the embryos injected early in incubation with much less than lethal doses. This would suggest that, as the chick ovum matures and takes on increased intercellular material, it becomes more resistant to irradiation.

No cytologic changes were observed that would suggest direct radiation injury of the stromal cells. A week or so after the radiation injury to the ova, the remainder of the ovary was hypoplastic but histologically showed no evidence of radiation injury. The extent of this hypoplasia was proportional to the degree of injury to the ova and remained after the significant irradiation had ceased. On the basis of these observations, it seemed possible that the ovarian hypoplasia which appeared some time after irradiation was dependent upon the changes in the ova and was not a direct result of radiation injury.

TABLE III: AVERAGE LENGTHS AND WEIGHTS OF TIBIAS FROM CONTROL AND IRRADIATED CHICKS EIGHT WEEKS OLD
(See Fig. 16)

	Weight (gm.)	Length (cm.)
Control	2.96	8.9
235 μc. 6 days after hatching	2.5	8.1
760 μc. 29 days after hatching	2.38	8.0
100 μc. on fourteenth day of incubation	2.06	7.9
100 μc. on fourteenth day of incubation plus 1,050 μc. 37 days after hatching	1.75	7.6

The female chicks irradiated during incubation did not show the lack of secondary sex characteristics seen in the male birds. However, such a change would be more difficult to detect in females, since a castrate bird in its lack of secondary sex characteristics resembles a female much more closely than a male.

The atrophy of the right ovary, which takes place during the latter part of incubation, did not resemble the atrophy following irradiation in that the latter showed primary early injury of the ova followed later by stromal atrophy, while the naturally occurring atrophy involved all ovarian elements simultaneously.

4. Effect of Radiation on Bone: The bone of developing embryos and chicks received heavier and more prolonged irradiation than did other tissue. P^{32} injected into the yolks of eggs early in incubation was relatively uniformly distributed throughout the embryo until after the ninth day of incubation, when calcified bone first forms. From then on, the P^{32} concentrated in the bone. Within the various parts of any given bone there was a significant difference in intensity of radiation. Concentration of P^{32} was directly proportional to the degree of calcification as evidenced by severe marrow injury in well calcified parts of bone and relatively little injury in the cartilaginous parts.

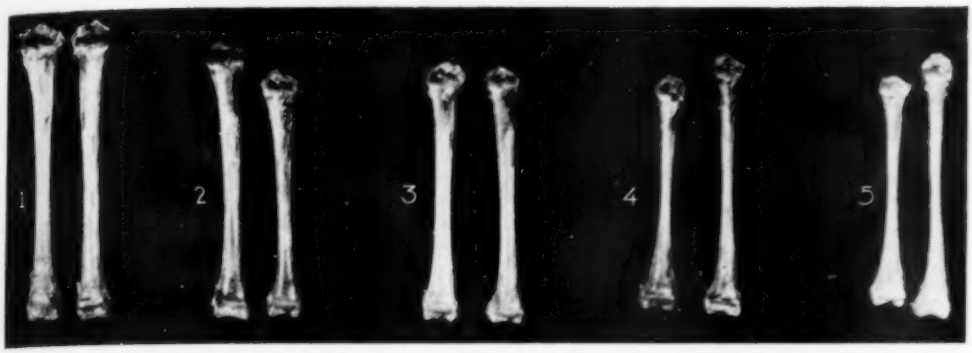


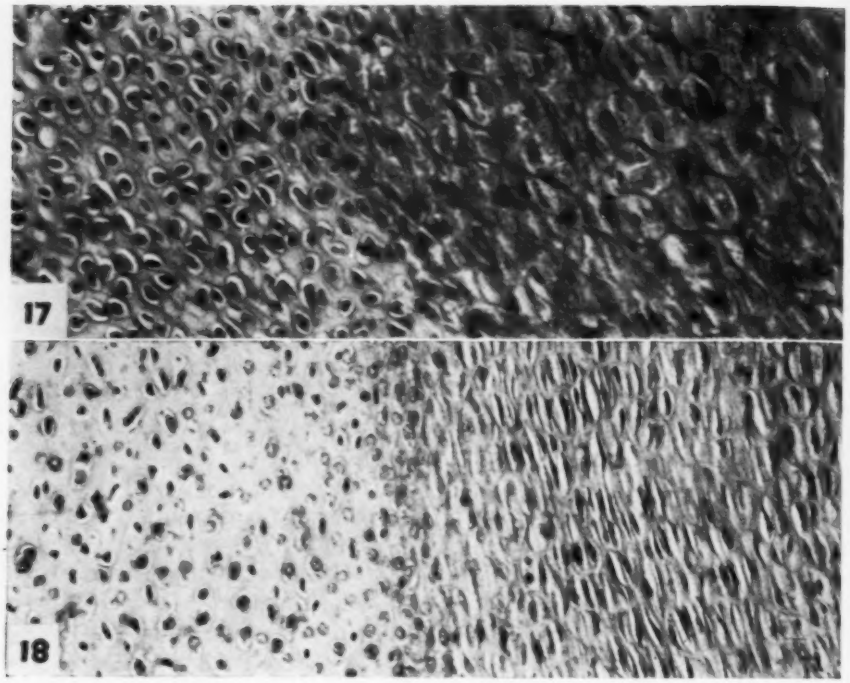
Fig. 16. Left tibias from 7-week chicks grouped as follows: 1. Controls. 2. 235 μc six days after hatching. 3. 760 μc twenty-eight days after hatching. 4. 100 μc on eighth day of incubation. 5. 100 μc on eighth day of incubation plus 1,050 μc twenty-nine days after hatching.
In spite of marked radiation effects, the bones maintain a normal shape, with no bowing or epiphyseal deformities. The pale color of bones in Group 5 is due to complete destruction of marrow and severe anemia. (Length and weights given in Table III.)

Gross examination showed the bones of embryos and chicks receiving radiation to be shorter and lighter than normal (Table III). The bones irradiated during incubation were much thinner and lighter than those irradiated later in life. In birds receiving sufficient irradiation to produce destruction of the marrow elements, the bones appeared pale white and almost translucent rather than normal gray-brown and opaque. There were no deformities, and the dwarfed bones retained normal proportion and structure (Fig. 16).

The ends of the tibia and femur making up the knee joint were used in the microscopic observations of radiation injuries to the bones because they could be easily cut and blocked to give comparable sections and because these bones continued to grow throughout our period of observation.

The radiation effects on developing bones were essentially the same whether the injection was into embryos or chicks. The rapidly dividing cartilage cells in the proliferating zone and epiphysis were the most radiosensitive. The effect on osteoblasts and osteoclasts was not obvious from cytologic studies, although there was some retardation of bone formation as evidenced by the thin cortical bone and reduced number of bony lamellae, which were nevertheless somewhat larger than normal.

Effects of various amounts of radiation on the bone development in embryos will be discussed first. The smallest dose used in studies of bone was 100 μc, injected on the fourteenth day of incubation. Effects were visible in both cartilage and bone four days later. The outstanding reaction was seen in the zone of proliferating cartilage. Chondrocytes were clearly injured. Mitoses were about 25 per cent of normal and the cells were elongate and irregular in shape. Changes in the bone were less striking and might be considered equivocal. The periosteal osteoblasts appeared smaller and less active than normal, and the cortical bone of the shaft was slightly thinned. Three days later, seven days after injection, the suppression of mitotic division and the abnormalities in shape of the injured chondrocytes were more marked. Chondrocytes were fewer in number, swollen, indistinct, and irregularly distributed. As a result, the zone of proliferation was thin and the lacunae of the epiphysis were enlarged. This stage of injury and the normal appearance may be compared in Figures 17 and 18. At this time the differences in size between normal and irradiated bones began to be apparent, suggesting an alteration in osteoblastic and osteoclastic activity. This same process continued, and three days later, ten

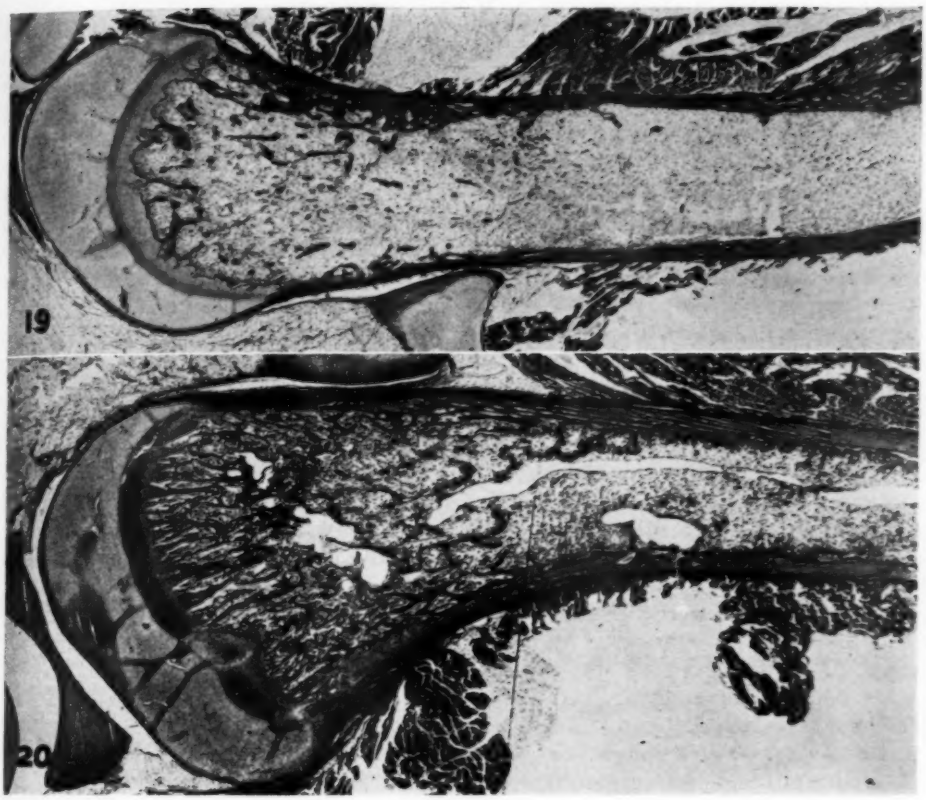


Figs. 17–18. Sections through lower epiphyseal lines of femurs from hatching chick given 100 μc on fourteenth day of incubation (Fig. 17) and control hatching chick (Fig. 18). Epiphyseal cartilage is to left and proliferating cartilage is to right of epiphyseal line in both figures. Irradiated epiphyseal chondrocytes have enlarged lacunae and decreased amount of intercellular hyalin. The epiphyseal line is less sharp in the irradiated bone. In the proliferating cartilage, radiation caused swelling and granularity of the cells and decreased cell division. ×400

days after injection, in addition to the structural abnormalities of the chondrocytes and the sluggish rate of mitosis, there was a loss in the amount of hyaline intercellular matrix in the epiphysis.

After the tenth day there was an increase in mitotic activity in the epiphysis and zone of proliferation, but an irregular arrangement of epiphyseal chondrocytes and a subnormal amount of hyaline matrix persisted. In a fifteen-day chick, the processes of cartilaginous resorption from the shaft and accompanying provisional calcification appeared to have exceeded the diminished cartilage proliferation, and the resorption of cartilage and provisional calcification were much closer to the epiphyseal line than in the normal. The osteoblasts and osteoclasts appeared normal, although the calcified shaft of the bone was still slightly thin. The bones of chicks examined seven weeks after hatching were significantly smaller than normal (Table III), but their histologic structure was not remarkable. Approximately the same amount of radiation to a younger embryo produced a similar but slightly more marked reaction and retarded recovery. However, even these changes resulting from severe prolonged suppression of growth were reversible, and in a chick of this series killed at fifty-one days of age the bones, while abnormally small, were histologically normal.

The most marked effect was observed following injection of 200 μc into eight- or fourteen-day embryos, a dose which was fatal fifteen days after hatching, but the changes were the same type as those seen in the less heavily irradiated birds. At hatching time, seven to twelve days after injection of 200 μc, the cartilage cells of



Figs. 19–20. Lower end of femur of fifteen-day chick given 200 μc on eighth day of incubation (Fig. 19) compared with normal of same age (Fig. 20). The irradiated specimen is small and shows a very narrow zone of proliferating cartilage adjacent to the epiphyseal line. Nearly all of the vesicular cartilage beyond the proliferating zone has been resorbed and replaced by only a few bony trabeculae in the zone of provisional calcification. The cortex of the irradiated shaft is very thin and the marrow cavity is devoid of blood-forming cells. ×12

the epiphysis were irregular in size, shape, and distribution. Some of the cells were swollen and stained poorly, and the cell boundaries were not visible as in the normal. They showed little, if any, mitotic activity, and many of the lacunae were enlarged. These abnormalities were more marked in the zone of proliferating cartilage which, nevertheless, was normal or only slightly decreased in thickness. There was less osteoblastic and osteoclastic activity in the shaft, resulting in fewer bony trabeculae in the center of the shaft and slight thinning of the cortex with a decreased number of lamellae, which appeared somewhat thicker than normal. In the moribund fifteen-day-old chicks the epiphyseal cartilage cells were irregularly placed; they showed little mitotic activity, and intercellular hyalin was markedly diminished. The zone of proliferating cartilage was one-third to one-half normal width and showed no mitotic activity. The cartilage resorption from the shaft had exceeded the limited cartilage proliferation and extended to the limits of the zone of proliferation. Osteoblastic and osteoclastic activity in the shaft was markedly reduced and the cortical bone was thin. A section through the lower end of the femur of one of these moribund birds is compared with a normal of the same age in Figures 19 and 20.

The changes in bone development caused

by injection of P^{32} into young chicks depended upon the size of the dose of radiation and the age of the chick at time of injection. The injury to the cells, however, followed the same pattern described in the irradiated embryos. Slight early changes were seen in a bird injected subcutaneously with 235 μc when six days old and killed two weeks later. The epiphyseal cartilage showed reduced mitotic activity but was otherwise negative. The zone of proliferating cartilage was two-thirds normal width and showed a reduced number of mitoses. The amount of unresorbed cartilage was normal, which indicated that, considering the apparently reduced rate of cartilage proliferation, the resportion must also be slowed. The provisional calcification also appeared to be lagging slightly. Finally, the cortex of the shaft of the long bone was slightly thinner than normal and osteoblastic and osteoclastic activity was somewhat decreased. A more advanced stage of this process was seen in a chick given 300 μc on the twenty-ninth day and killed on the forty-third day. The epiphyseal cartilage had recovered and was negative. The zone of proliferating cartilage was slightly narrowed and still showed some reduction in mitotic activity. The cartilage beyond the proliferating zone had been resorbed almost completely because of greater inhibition of cartilage growth than resorption. There was accompanying provisional calcification much closer to the epiphyseal line than in the control. Decreased osteoblastic and osteoclastic activity were evident in the thinned cortex. Fatal courses of P^{32}, 1,118 μc and 3,696 μc, given to young chicks produced severe damage to the chondrocytes. In the proliferating zone of epiphyseal cartilage, which was only one-third to one-half normal thickness, the few remaining cells were swollen and pale, lying in the hyaline matrix with no vestige of normal columnar pattern. All cartilage beyond this narrow inactive proliferating zone had been resorbed, and a rather smooth, ossified line marked the edge of the proliferating cartilage. Osteoblastic and osteoclastic activity had ceased completely. The cortex of the shaft was thinner than normal, and the lamellae were fewer but somewhat thicker than normal.

Discussion: The concentration of P^{32} in calcified bone produced more prolonged and intense radiation in the skeleton than in soft tissues. The result was an obvious retardation in growth without, however, any distortion of the gross appearance of the bone. The birds that survived heavy doses were found weeks later to have bones of normal histologic structure, although they were dwarfed. The effects were essentially the same in embryos and growing chicks. The cartilaginous epiphysis and especially the zone of proliferating cartilage were most sensitive to radiation, while osteoblasts and osteoclasts were relatively resistant.

The earliest histologic effects of radiation, which appeared within a few days, were the cessation of mitotic activity and irregular swelling, vacuolation, and granularity of the chondrocytes. As the radiation continued, there was a decrease in intercellular hyalin of the cartilage, an irregularity in distribution of the cartilage cells of the epiphysis, and a narrowing of the zone of proliferating cartilage, with swelling and degeneration of the cells.

The processes of cartilaginous resorption in the shaft and accompanying provisional calcification were not as completely inhibited by radiation as was the proliferative process. Thus, after a prolonged period of irradiation, all the vesicular cartilage was resorbed and a strip of provisional calcification was laid down along the thin and inactive zone of epiphyseal cartilage.

The bone formation in the shaft was also retarded, as evidenced by the thin cortical bone made up of a reduced number of bony lamellae which tended to be larger than normal. This change in cortical bone suggests a reduction in osteoblastic and osteoclastic activity which normally is responsible for the definitive modeling of the bone structure.

This injury was reversible even when

extreme and, after the activity of the retained P^{32} decreased to a point of insignificance, cartilaginous proliferation was resumed and the rest of the bony architecture returned to normal. Growth proceeded apparently unimpaired from then on, for in chicks several weeks after the period of heavy radiation the bones were all but indistinguishable histologically from normal.

SUMMARY

Chick embryos and young chicks were exposed to continuous radiation by injections of P^{32}. The P^{32} concentrated largely in the bones of the embryos and chicks. The radiation caused an over-all growth retardation, resulting in small but well proportioned birds.

Both testes and ovaries were found to be among the most radiosensitive organs and were the least able to recover from injury. The primitive sex cells in either gonad were the most sensitive element. The spermatogenic cells of the testis remained extremely radiosensitive throughout their development, while the ova became more radioresistant as they matured. The somatic cells of the gonads were much more radioresistant than the sex cells, but their rate of growth was inhibited following injury to the sex cells.

Bone growth was retarded by radiation. The cartilage cells of the epiphysis were much more radiosensitive than the osteoblasts and osteoclasts. After radiation ceased, the bones regained a normal histologic structure but remained dwarfed.

NOTE: The authors are indebted to Dr. Olive Gates for invaluable assistance in the preparation of this work.

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SUMARIO

Efectos de la Irradiación Continua sobre los Embriones de Pollo y los Pollos en Vías de Desarrollo. I. Velocidad del Crecimiento, Gonados y Hueso

Embriones de pollo y polluelos fueron expuestos a la irradiación continua por inyecciones de P^{32}. El P^{32} se concentró en gran parte en los huesos de los embriones y pollos. La irradiación acarreó un retardo general del desarrollo, dando por resultado aves pequeñas, pero bien proporcionadas.

Tanto los testículos como los ovarios figuraron entre los órganos más radiosensibles, mostrándose como los menos capaces de reponerse de las lesiones. Las primitivas células sexuales de uno o otro gonado constituyeron el elemento más susceptible. Las células espermatógenas del testículo continuaron siendo sumamente radiosensibles durante todo su desarrollo, en tanto que los huevos se volvieron más radiorresistentes a medida que maduraban. Las células somáticas de los gonados fueron mucho más radiorresistentes que las sexuales, pero una vez lesionadas las últimas se inhibía la velocidad del desarrollo de las primeras.

Los osteogenia fué retardada por la irradiación. Las células cartilaginosas de la epífisis mostráronse mucho más radiosensibles que los osteoblastos o los osteoclastos. Después de cesar la irradiación, los huesos recobraron su histología normal, pero permanecieron empequeñecidos.

EDITORIAL

Radiation Protection

The matter of radiation protection for his patient and himself has long been of intimate concern to the radiologist. Almost from the first use of x-rays, and gamma rays from radium, there has been a certain degree of awareness of their potential danger if used carelessly, but it was not until about 1920 that serious numbers of radiation "burns" began to be evident. This coincided with the introduction of the Coolidge type of tube with its higher output and greatly expanded field of application, with consequent recognition of the need for even greater care in protection.

In 1928 the first set of radiation protection rules or recommendations was adopted on an international basis by the Second Congress of Radiology in Stockholm. In these rules agreement was reached on some of the broader factors involved, but since ready agreement on details was not attainable, these were left for future amplification by individual countries. It is of interest to note how little these 1928 rules have required alteration other than to cope with our rapidly extending horizon of available x-ray energies.

In 1929, an effort to amplify and extend the recommendations of the International Commission, suitable to the radiological needs of this country, was undertaken. Upon the recommendation of the International Commission on X-ray and Radium Protection, the Advisory Committee on X-ray and Radium Protection was formed by the Bureau of Standards and composed of representatives of the Radiological Society of North America, the American Roentgen Ray Society, the National Research Council, the American Medical Association, and x-ray and radium manufacturers. This group formulated the well known Handbooks on X-ray Protection in 1930 and 1935 and Radium Protection in 1938. These served as the major bases for later codes on industrial x-ray and radium protection and for the operation of the Manhattan District in its early days.

Need for revision of Handbook 20 on X-ray Protection was felt some years ago, but the war interfered with the work. When this revision was finally undertaken in 1947, it was realized that the problem of radiation protection had been so broadly expanded by the advent of atomic energy as to necessitate an enlargement and reorganization of the original committee. The sponsorship was enlarged to include representation of the Atomic Energy Commission and United States Public Health Service, and the name was changed to National Committee on Radiation Protection. It now comprises eight subcommittees to deal with the following subjects: permissible external exposure; permissible internal exposure; x-rays up to two million volts; gamma rays and electrons above two million volts; protons, neutrons and heavy particles; handling of radioactive isotopes; radiation instrumentation and measurement; waste disposal and decontamination. In addition to representatives from the parent organizations, the Committee has included in its membership outstanding authorities throughout the country on all phases of radiation protection. It is doubtful if a more experienced body of protection experts could be found.

The first of the new reports prepared by this Committee will be Handbook 41 on *Medical X-ray Protection Up to Two Million Volts.*[1] This will be a complete revision of the earlier handbook. One of the

[1] This Handbook can be obtained from the Superintendent of Documents, Government Printing Office, at a cost of $0.15 per copy.

major changes consists in a more detailed presentation of protective barrier requirements. In the international recommendations and previous handbooks a single table of lead thicknesses was given. These applied only to direct beam shielding at one meter from the tube under average operating conditions. Literal use of these figures often resulted in over-protection (particularly for scattered radiation) and excessive installation costs. The new recommendations take into consideration such factors as distance, tube output, scattered or direct radiation, different kinds of protective materials, etc. It should now be possible to design shielded installations affording adequate protection with substantial savings in cost.

Other handbooks on *The Safe Handling of Radioactive Isotopes, Permissible Exposure of the Body to External Radiations,* and *Radiological Instrumentation* are now nearing completion and announcements of their release will be made later.

The needs, interests, and assistance of the radiological organizations of the country have been essential in the preparation of these recommendations. Their continued help in the form of comments and suggestions is required in order that future handbooks may continue to serve the radiological profession in providing up-to-date data and methods in the field of radiation protection.

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SIXTH INTERNATIONAL CONGRESS OF RADIOLOGY

As announced in the March issue of RADIOLOGY, the Sixth International Congress of Radiology will be held in London from July 23 to July 30, 1950, under the presidency of Dr. Ralston Paterson, of Manchester. The headquarters of the Congress will be at the Central Hall, Westminster, which will also house an extensive Scientific Exhibit. The Technical Exhibit of apparatus will be located in the Halls of the Royal Horticultural Society nearby.

The subjects chosen for the main scientific meetings are:

1. *General Congress Scientific Meetings*
   - (*a*) Radiological Achievement, 1937–50
   - (*b*) Mass Radiology of the Chest
   - (*c*) Supervoltage Radiotherapy
   - (*d*) Radiation Hazards
2. *Diagnosis Section Symposia*
   - (*a*) Skeletal Changes in Blood Diseases
   - (*b*) Radiology of the Small Intestine
   - (*c*) Arthrography
   - (*d*) Angiocardiography
3. *Therapy Section Symposia*
   - (*a*) Method of Presentation of Results of Treatment
   - (*b*) Radioactive Isotopes
   - (*c*) Cancer of the Larynx
   - (*d*) Cancer of the Breast
4. *Biology Section Symposia*
   - (*a*) Radiation Histology
   - (*b*) Radiation Chemistry
   - (*c*) Radiation Genetics
   - (*d*) Mode of Action of Ionizing Radiations
5. *Physics Section Symposia*
   - (*a*) Acceleration of Particles and the Generation of Ionizing Radiations
   - (*b*) Radiological Units
   - (*c*) Radiotherapeutic Physics
   - (*d*) Production and Physical Properties of Radioisotopes

Selected speakers will be invited to contribute the major portion of these symposia. Other sessions will be devoted to the reading of papers proffered by authors on their own topics.

A varied and interesting social program is being arranged for members of the Congress, and special attention is being paid to the entertainment of Associates accompanying Members.

During the week preceding and the two weeks following the Congress, demonstrations will take place in the radiological departments of a number of London hospitals. Planned tours to centers of interest in Great Britain and Ireland are being arranged to follow the Congress; they will include excursions to the neighboring countryside by coach, visits to buildings of historical interest, demonstrations at hospitals, and a full social program.

Those wishing to attend the Congress as Full Members (£7.7*s*.0*d*.) or as Junior Members (under thirty years of age on Jan. 1, 1950—£4.4*s*.0*d*.) must be members of a radiological society, or sponsored by a radiological society. Ladies and children accompanying Members can be registered as Associate Members (£3.3*s*.0*d*.). Associate Membership is also open to members of the technical staffs of radiological departments and laboratories, or of the x-ray industry. A late fee will be charged to those registering after April 1, 1950.

Members of the Congress may make their travel and hotel reservations through any office of Messrs. Thomas Cook & Son, Ltd. (or their associated company, the Cie Internationale des Wagonslits), who have been appointed the official travel agents for the Congress.

It is planned shortly to issue a detailed program with registration forms to the members of radiological societies. All communications in connection with the Congress should be addressed to the Secretary-General at 45 Lincoln's Inn Fields, London, W.C.2.

NOTE: It has just been learned that H.R.H. the Princess Elizabeth hopes to open the Congress.

AMERICAN BOARD OF RADIOLOGY INSPECTION OF TRAINING FACILITIES

Since the formation of the American Board of Radiology in 1934, its members and sponsors have realized that the standards of its examination could not be raised higher than the standards of training in radiology. Prior to 1941 there was a marked paucity of available residencies, and during those years the primary effort was devoted to encouraging institutions to inaugurate residency training. In September 1941, the American Board of Radiology ruled that after Jan. 1, 1945, no candidate would be admitted to examination who had not completed three years of residency training in an approved department of radiology. Unfortunately, on Dec. 7, 1941, we were precipitated into World War II and our plans made only three months earlier went up in smoke.

Immediately after the war was over, our Board, along with all specialty boards, realized that there would be many young men returning from service demanding residency training, and in order to accommodate these young men, we entered into an agreement with the Council on Medical Education and Hospitals of the American Medical Association to make a cursory inspection of the applications sub-

mitted by any department of radiology and to give temporary approval for residency training until such time as the Board and the Council could review these programs.

The time has now come when we consider this emergency to be over and we must put our house in order by raising the standards of training in radiology. There are many of the older institutions which have been approved for a great many years whose personnel in the department of radiology has changed considerably. Therefore, it has now been deemed wise by the Board to review all our residency programs, including those already approved, both permanently and temporarily, as well as those applying for approval.

The Council on Medical Education and Hospitals of the A.M.A. has done an outstanding job in inspecting and evaluating the residency programs in all specialties and has co-operated harmoniously with the Boards. We therefore have no desire or intention of interfering with this fine work, but it has been decided, with the full approval of the Council, that the Board of Radiology will conduct its own inspection of all its residency programs. It is not our plan, however, to repeat this survey for many years, if at all.

Between forty and fifty outstanding radiologists with teaching experience have been invited to assist in making the inspection. Each department of radiology offering training in radiology, which is either already approved or seeking approval, will be visited by one of these men.

This program will require several months to complete and it is therefore hoped that those departments of radiology seeking initial approval will be patient with us until it is completed.

B. R. KIRKLIN, M.D., *Secretary*

PENNSYLVANIA RADIOLOGICAL SOCIETY

The following is the program of the Thirty-fourth Annual Meeting of the Pennsylvania Radiological Society, at Bedford Springs Hotel, Bedford, Penna.

Friday, May 20

9:00: Address of Welcome
9:15: Film-Reading Session, George W. Chamberlin, M.D., Reading, Chairman
11:00: Use of Hyaluronidase in Subcutaneous Urography, John W. Hurst, M.D., Altoona
11:20: Cystitis Pneumatosa, Joseph T. Danzer, M.D., Oil City
11:50: Mucoceles of the Fronto-ethmoidal Sinuses, Russell Wigh, M.D., Philadelphia
12:10: Roentgen Demonstration of Complications of Mastoid Disease, Barton R. Young, M.D., Philadelphia
2:00: Roentgen Therapy in Non-Malignant Gynecologic Conditions, Theodore P. Eberhard, M.D., Philadelphia
2:25: A Type of Irradiation Effect in Metastasis to Cervical Lymph Nodes, Mary Helen Cameron, M.D., and Andrew J. Donnelly, M.D., Philadelphia
2:50: Treatment of Cervical Metastases, S. Gordon Castigliano, M.D., Philadelphia
3:15: Long Survival in Malignant Lymphoma, Edwin J. Euphrat, M. D., Pittsburgh
4:00: Fibrous Dysplasia of Bone, S. P. Perry, M.D., Sayre
4:30: Business Meeting

Saturday, May 21

9:00: Film-Reading Session, Paul C. Swenson, M.D., Philadelphia, Chairman
11:00: Anatomy of the Tracheobronchial Tree, Gerald D. Dodd, M.D., Philadelphia
11:20: Experience with Cardiac Catheterization, Angiocardiography, and Thoracic Aortography, J. Stauffer Lehman, M.D., Philadelphia
12:00: Business Meeting
2:00: Lesions in the Upper Third of the Stomach, J. H. Harris, M.D., Harrisburg
2:30: Primary Tuberculosis, John Caffey, M.D., New York, N. Y.

ATLANTA RADIOLOGICAL SOCIETY

On March 11, 1949, at a called meeting of the radiologists of Atlanta, Georgia, the Atlanta Radiological Society was organized. Meetings of the new society will be held on the second Friday evening of each month except during the three summer months. The officers are: President, Dr. J. J. Clark; Vice-President, Dr. Charles A. Priviteri; Secretary-Treasurer, Dr. W. W. Bryan, 490 Peachtree St., N. E., Atlanta.

COMMONWEALTH LECTURES LOUISVILLE, KENTUCKY

Dr. Merrill C. Sosman, as Commonwealth Visiting Professor of Radiology, delivered a series of lectures at the Louisville General Hospital, April 4–8. His subjects were: Radiology of the Skull; Roentgenology in the Diagnosis of Heart Disease; Roentgenology in the Study of the Gallbladder; The Gastro-Intestinal Tract as Seen by the Roentgenologist; Some Observations on Cushing's Disease. On April 8, at a joint dinner meeting of the Louisville Medico-Chirurgical Society and the Louisville Radiological Society, Dr. Sosman spoke on "The Historical Development of Our Knowledge of Pituitary Tumors."

ST. LOUIS SOCIETY OF RADIOLOGISTS

At a recent meeting of the St. Louis Society of Radiologists, Dr. Don C. Weir was elected President and Dr. Charles J. Nolan, 737 University Club Bldg., St. Louis 3, Mo., Secretary-Treasurer.

VIIème CONGRES DES MEDECINS ELECTRO-RADIOLOGISTES DE LANGUE FRANCAISE

The Seventh Congress of the French Speaking Electro-Radiologists will be held at the Faculte de Médecine, Paris, October 10 to 15, 1949. Professor Paul Lamarque of Montpellier is President of the Congress. Other officers are Professor Maisin of Louvain, Belgium, Dr. Dariaux of Paris, and Dr. Proux of Paris.

TWENTY-FIVE YEARS OF RADIOTHERAPY BELLEVUE HOSPITAL, NEW YORK

The twenty-fifth anniversary of the establishment of the Radiation Therapy Department of Bellevue Hospital, under the direction of Dr. Ira I. Kaplan, was marked by a special clinical gathering of the department's alumni, on March 24, 1949, with lectures by Dr. Bradley L. Coley, on "Bone Tumors—A Field Requiring Co-operation Between the Radiologist and the Surgeon," Dr. Douglas A. Quick, on "Advances in Radiation Therapy in the Past Twenty-Five Years," and Dr. I. C. Rubin, on "Twenty-Five Years Experience with Irradiation Treatment for Sterility Associated with Habitually Delayed Periods." Luncheon was followed by a clinical demonstration of the work of the department, and the celebration concluded with a testimonial dinner to Dr. Kaplan.

BROOKHAVEN NATIONAL LABORATORY NUCLEAR REACTOR

The construction of a nuclear reactor (atomic pile) and auxiliary laboratories is nearing completion at Brookhaven National Laboratory, and initial operation is expected in the Fall of 1949. The reactor has been designed to provide a unique facility to serve the needs of the scientific, engineering, and industrial institutions located in the northeastern part of the United States.

The reactor is an air-cooled unit constructed of graphite and unenriched uranium. The maximum thermal neutron flux is expected to be about 5×10^{12} neutrons per square centimeter per second. For experiments, one hole 12 in. square, and several 4-in. square holes penetrating the shield at various levels, will permit the insertion of apparatus in the interior of the reactor and the release of collimated neutron beams. The over-all width of the reactor, including the shield, is about 38 ft. in the direction of the 4-in. openings. A number of automatic devices will allow controlled irradiation of samples for periods as short as ten seconds. The top shield of the reactor consists of removable 4-ft. square blocks. It will accommodate thermal columns and large equipment designed to utilize leakage thermal neutron flux (in excess of 10^{11} neutrons per square centimeter per second). Provision has been made for cages in which large size laboratory animals can be moved under the reactor. It will be possible to conduct research on three vertical faces of the reactor, as well as at the top and bottom.

Laboratories specially designed for handling radioactive materials are included in the reactor building. They will accommodate more than eighty scientists and technicians for research in physics, chemistry, biology, and medicine.

A "hot" laboratory is being constructed near the reactor building, linked with the latter by a monorail and by pneumatic tubes for transporting irradiated material. Its completion, however, will be deferred until after the completion of the reactor.

Letter to the Editor

WORKMEN'S COMPENSATION SETTLEMENT BARS MALPRACTICE SUIT

To the Editor of Radiology

DEAR DR. DOUB:

I believe that your readers will be interested in a decision recently given out by the Supreme Court of New Jersey to the effect that acceptance of a personal injury award under the Employers Compensation Law bars recovery for alleged malpractice.

An employee of an aeronautical corporation in Jersey City, N. J., received an injury to several fingers of her right hand and was cared for by the physicians who were treating injuries to the plant's employees. The patient received and accepted the compensation awarded for the injury and settled for the same.

Later she brought suit against the physician who attended her in the injury to her hand, claiming dissatisfaction with the end-result and alleging that the plant physician had been negligent in the diagnosis and treatment.

The trial court rendered a verdict for the plaintiff, and the case was appealed to the Supreme Court.

The New Jersey Supreme Court, after reviewing the case, decided that the Workmen's Compensation Act implies liability for compensation on the employer, regardless of fault, and provides a remedy to employees for accidental injury or injuries arising out of and in the course of employment. Accordingly full compensation was paid by the employer and accepted by the employee for the disability attributable to her injury. "*She is entitled,*" said the Supreme Court, "*to only one satisfaction for that injury. If that injury was aggravated by any alleged negligence of the physicians the remedy provided by the Compensation Act is inclusive and is covered. Any aggravation of the original injury not caused by an independent intervening act is considered compensated. The employee's right of action for the alleged negligence against the physicians was therefore barred by the acceptance of the compensation*

award." [Burns *vs.* Vilardo, 60 Atl. R. (2nd) 94. New Jersey 1948]

This is a very important and far-reaching decision and tends toward placing the physician in a better position in cases of alleged late bad results of medical care, following personal injuries growing out of employers liability injuries. This type of injury is and has been a very fruitful one for ambulance-chasing lawyers and their money-grasping clients.

I. S. TROSTLER, M.D.
Chicago, Ill.

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE FUNDAMENTALS OF PULMONARY TUBERCULOSIS AND ITS COMPLICATIONS FOR THE STUDENT, THE TEACHER, AND THE PRACTICING PHYSICIAN. Sponsored by the American College of Chest Physicians. Editor, EDWARD W. HAYES, M.D. Editorial Committee, Andrew L. Banyai, M.D., Herman Hilleboe, M.D., J. Arthur Myers, M.D., and J. Winthrop Peabody, M.D. Twenty-eight authors. A volume of 480 pages, with 182 illustrations and 2 color plates. Published by Charles C Thomas, Springfield, Ill., 1949. Price $9.50.

Book Reviews

NEOPLASMS OF BONE AND RELATED CONDITIONS: THEIR ETIOLOGY, PATHOGENESIS, DIAGNOSIS, AND TREATMENT. By BRADLEY L. COLEY, M.D., Attending Surgeon, Bone Tumor Department, Memorial Hospital for Cancer and Allied Diseases; Assistant Professor of Clinical Surgery, Cornell University Medical College. A volume of 766 pages, with 622 illustrations and 53 tables. Published by Paul B. Hoeber, Inc., New York, 1949. Price $17.50.

In this work on Bone Neoplasms, Dr. Coley has supplied a long-felt need for the radiologist and others upon whom falls the responsibility for the diagnosis and care of these lesions. It is a veritable storehouse of information, not only on the true neoplasms of bone, both benign and malignant, but also on other conditions affecting the skeletal system which may cause confusion in diagnosis. The contents reflect the wide experience of the author in this field and epitomize the information gleaned from a study of the vast material of the bone tumor department of New York's Memorial Hospital. The work will be of inestimable value to the radiologist, to all clinicians, and in particular to the orthopedic surgeon, with whom the final decision as to therapy so often rests.

The scope of the work is suggested by the titles of the Sections into which the text is divided: Classification, Etiology, and Diagnosis; Benign Tumors and Tumorlike Lesions of Bone; Primary Malignant Tumors of Bone; Tumors Involving Bone by Extension; Metastatic Tumors Involving Bone; Tumors of Bone in Special Localities: Surgical Treatment; Radiation Therapy; Constitutional Therapy; Lesions of the Skeletal System That May Simulate Neoplasm of Bone. A final section, headed Miscellaneous, takes up pathologic fractures, the medicolegal aspects of trauma in connection with bone tumors, and the experimental production of bone sarcoma.

In general, the author has stressed chiefly the clinical aspects of bone tumors, with somewhat less attention to the microscopic pathology. The chapter on Osteogenic Sarcoma is a good example of his method. Beginning with the classification of the Bone Sarcoma Registry and a brief description of each type of tumor, he goes on to a consideration of the clinical features, the differential diagnosis, a critical discussion of the various forms of therapy, and remarks on prognosis, with an analysis of cases treated at Memorial Hospital. Under Unusual Forms of Osteogenic Sarcoma he takes up Albers-Schönberg disease, extraskeletal osteogenic sarcoma, of which he reports an interesting case, osteogenic sarcoma arising in benign bone lesions, and osteogenic sarcoma developing after fracture. A discussion on sarcoma in irradiated bone completes the chapter.

The volume is well bound, attractive in format, and amply illustrated, with valuable bibliographies following each section and an adequate index.

NEURORADIOLOGY. By ALEXANDER ORLEY, M.D., F.F.R., D.M.R. & E., Hon. Consulting Radiologist, West End Hospital for Nervous Diseases, London. A volume of 422 pages, with 572 illustrations. Published by Charles C Thomas, Springfield, Ill., 1949. (In England by Blackwell Scientific Publications, Ltd., Oxford. In Canada by the Ryerson Press, Toronto.) Price $11.50.

This compact and readable treatise on neuroradiology is based on the author's ample experience in the Hurstwood Park Neurological Hospital and the West End Hospital for Nervous Diseases in London.

The various x-ray technics and diagnostic findings are covered in a well organized manner. Many of the radiographic reproductions, however, suffer from the usual lack of detail, accentuated occasionally by inadequate labeling.

Cerebral angiography, arteriography, peripheral arteriography, ventriculography, and encephalography are covered in sufficient detail. When opportune, clinical statistics are discussed, particularly in the chapters on brain tumors and prolapsed intervertebral disks. In addition to the skull, spinal x-ray pathology, myelography, and the various neuropathic disturbances receive adequate mention.

The style is easy and free flowing. Adequate, but not exhaustive, coverage is made of the subject matter. An extensive bibliography is included. This is a desirable book for the neurologist and neurosurgeon as well as for the radiologist.

CAMPBELL'S OPERATIVE ORTHOPEDICS. Editor, J. S. SPEED, M.D.; Associate Editor, HUGH SMITH, M.D., Memphis, Tenn. Two volumes of 1644 pages, with an index of 44 pages, and with 1141 illustrations, including 2 color plates. Published by C. V. Mosby Co., St. Louis, Mo., 2nd ed., 1949. Price $30.00.

The new edition of Campbell's *Operative Orthopedics* represents a formidable amount of information, clinical experience, and surgical technic. In its pages the resident in training will find elementary data well outlined, while the clinician will have several methods from which he can select the procedure most applicable to his problem.

The work has been completely revised, with the addition of new chapters on Fractures, Peripheral Nerve Injuries, Amputations, and Cerebral Palsy. The subjects of fracture care, arthrodesis, arthroplasty and correction of deformities are well treated. Various accepted technics are described in detail. The advantages and indications of each one are noted. Especially worthy of mention is the section on the Nervous System, which includes the corrective procedures for paralyses, such as poliomyelitis, and the excellent description of cerebral palsy as conceived by Dr. Phelps. The discussion of scoliosis brings out the latest concepts of that condition. Hand surgery is wisely omitted for the most part, as this subject could not be presented adequately in a treatise of this scope.

This Second Edition of a standard work represents one of the best reference sources available for the graduate student and the surgeon. The illustrations with their context not only add to the appearance of the volumes, but also enhance their value to the reader. A well organized index and bibliography are included.

With three exceptions, the contributors are staff members of the Campbell Clinic. Doctors Speed and Smith have produced a well arranged and well executed piece of work. These volumes, justly dedicated to Dr. Campbell, will stand as a monument of which he would have approved.

ANATOMIE RADIOLOGIQUE NORMALE. OPTIQUE RADIOLOGIQUE ET DÉPISTAGE DES ERREURS DE LECTURE DES CLICHÉS. By HENRY TILLIER, Electroradiologiste des Hôpitaux d'Alger. A volume of 234 pages, with 350 figures representing tracings of films. Published by G. Doin & Cie, 8 Place de l'Odeon, Paris, France. Price 600 fr.

The author, after describing the well known principles of radiologic optics, applies his method of careful analysis by the tracing of films to the study of normal cases, stressing the instances where the x-ray images may be misleading and describing in detail the optical causes.

The book is divided into eleven chapters. The first refers to the laws of radiologic optics. The next three deal with the upper and lower extremities, including the shoulder and the hip. The fifth chapter describes the spine, the sixth the bones of the thorax, and the seventh the pelvis. The eighth chapter deals with the head, including the development of its bones and their relations to the contents of the cranium. Subsequent chapters deal with the thoracic organs—lungs, heart, and great vessels—and the digestive tract; the organs related to the digestive system, such as the liver, the gallbladder, and the spleen, with the use of contrast media whenever possible; and the urinary and genital organs.

In each one of his descriptions the author emphasizes the regions which generally cause the greatest difficulties of interpretation, pointing out possible sources of error in the interpretation of normal structures. In the case of the skeleton, he stresses such regions as the face, the petromastoid region, and the base of the skull. In his discussion of the thoracic organs he points out the structures of the hilus of the lung, the projection of the cardiac cavities in different views, and the shadows of the great vessels. In the colon, the ceco-appendicular and terminal ileum region are carefully described. As to the urinary and genital organs, special reference is made to descending and ascending urography and the aspects of the uterus, fallopian tubes, and ovarian regions, studied by means of opaque oil.

The originality of this books lies in the painstaking tracings of some 30,000 films which are the basis of the work. Reproductions are all of these tracings, without a single one of the original films.

The tracings are very accurately done, stressing the images that tend to cause confusion, especially when irregular planes coincide, as projected on a film. In cases of doubt this book will prove useful for reference, and comparison of the film with the accurate tracing of the normal film should be a valuable aid in reaching a correct conclusion.

DIE DURCHLEUCHTUNGSTECHNIK DER THORAXORGANE [The Technic of Fluoroscopy of the Chest]. By E. A. ZIMMER, Privatdozent of the University of Basel and Chief of the Roentgen Institute and Institute for Physical Therapy in the Cantonal Hospital of Fribourg. A volume of 120 pages, with 66 illustrations. Published by Benno Schwabe & Co., Basel, 2d ed., 1949. Imported by Grune & Stratton, Inc., New York.

Professor Zimmer has written a book mainly for use of the general practitioner or internist who should make a wider use of fluoroscopy of the chest. A clinical examination of the lungs without fluoros-

copy or films cannot be considered a complete examination. With this in view, the author has furnished a very practical and reliable guide for this field, without giving the impression that fluoroscopy is entirely adequate. He emphasizes its limitations and the limitations of the practitioner.

Enough technical considerations are given to instruct the physician about the danger of unlimited fluoroscopy to the patient and himself. Throughout the volume there are various technical hints, some of which are advantageous to the specialist. By well conceived diagrams, the more common diseases of lungs, heart, and mediastinum are depicted. Unusual and complicated chest diseases are rightly omitted in order not to confuse a non-specialist.

For the beginner in chest fluoroscopy, this little book may be of considerable help, and the experienced physician may find in it some practical hints for a more efficient fluoroscopy of the chest organs. The value of films for a more detailed and accurate diagnosis is emphasized. Fluoroscopy should be used for screening purposes and should improve the chest diagnosis of general practitioners and internists considerably.

DIE RÖNTGENDIAGNOSTIK DER WIRBELSÄULE UND IHRE GRUNDLAGEN [Roentgen Diagnosis of the Vertebral Column]. By DR. MED. ADOLF LIECHTI, Professor of Radiology and Director of the Roentgen Institute, University of Berne. Second revised and enlarged edition, completed by DR. MED. A. EGGLI. A volume of 364 pages, with 234 illustrations. Published by Springer-Verlag, Vienna, 1948.

Unfortunately Professor Liechti died before the second edition of his book on the diagnosis of vertebral lesions could be finished. The work has been completed by Eggli and appears as a volume of 364 pages, of which nearly a hundred are devoted to bibliography. The text is divided into four parts, as follows: (1) Development; (2) Anomalies and Variations of the Human Vertebrae; (3) Diseases of the Vertebrae; (4) Injuries of the Vertebrae.

Parts 1 and 2 reflect the author's great interest in the development and anomalies of the spine. These two chapters are quite complete and will appeal to those whose fundamental interest is in the vertebral column. The remaining two parts of the book are essentially a synopsis or abstract of the literature relating to the various subjects and as such present a great deal of information in a condensed manner.

In the extensive bibliography the author apparently has listed all of the references concerning the subject that were available to him, regardless of whether or not they are referred to in the text. This procedure, frequently used in European literature, will be useful perhaps to those without access to the usual indexes of a medical library.

It is stated that the text is definitely not for the beginner. On the other hand, a specialist will consider the discussion of many subjects too brief for his purpose.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

UNITED STATES

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Hugh F. Hare, M.D., 605 Commonwealth Ave., Boston 15, Mass.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Harold Dabney Kerr, M.D., Iowa City, Iowa.

AMERICAN COLLEGE OF RADIOLOGY. *Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6, Ill.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. D. Anderson, M.D., 2501 6th St., Tuscaloosa.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Wybren Hiemstra, 1414 S. Hope St. Meets monthly, second Wednesday, County Society Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB. *Secretary*, Charles E. Grayson, M.D., Medico-Dental Bldg., Sacramento 14. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

SAN DIEGO ROENTGEN SOCIETY. *Secretary*, R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Wm. F. Reynolds, M.D., University Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at San Francisco Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Mark S. Donovan, M.D., 306 Majestic Bldg., Denver 2. Meets third Friday of each month, at the Colorado School of Medicine and Hospitals.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Fred Zaff, M.D., 135 Whitney Ave., New Haven. Meetings bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, Ellwood W. Godfrey, M.D., 1676 Boulevard, W. Hartford. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, Alfred A. J. Den, M.D., 1801 K St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Auditorium.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, F. K. Hurt, M.D., Riverside Hospital, Jacksonville. Meets in April and in November.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wm. W. Bryan, M.D., 490 Peachtree St., N. E. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert Drane, M.D., De Renne Apartments, Savannah. Meets in November and at the annual meeting of State Medical Association.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, T. J. Wachowski, M.D., 310 Ellis Ave., Wheaton. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital Springfield. Meetings quarterly as announced.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Harold L. Shinall, M.D., St. Joseph's Hospital, Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, William M. Loehr, M.D., 712 Hume-Mansur Bldg., Indianapolis 4. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Anthony F. Rossitto, M.D., Wichita Hospital. Wichita. Meets annually with State Medical Society.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Everett L. Pirkey, M.D., 323 East Chestnut St., Louisville 2.

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, Everett L. Pirkey, Louisville General Hospital, Louisville 2. Meets second Friday of each month at Louisville General Hospital.

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary*, J. Howard Franz, M.D., 1127 St. Paul St., Baltimore 2.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, George Belanger, M.D., Harper Hospital, Detroit 1. Meetings first Thursday, October to May, at Wayne County Medical Society club rooms.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS. *Secretary-Treasurer*, R. B. MacDuff, M.D., 220 Genesee Bank Building, Flint 3.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, C. N. Borman, M.D., 802 Medical Arts Bldg., Minneapolis 2. Meets in Spring and Fall.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Wm. M. Kitchen, M.D., 1010 Rialto Building, Kansas City 6, Mo. Meetings last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Charles J. Nolan, M.D., 737 University Club Bldg. Meets on fourth Wednesday, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ralph C. Moore, M.D., Nebraska Methodist Hospital, Omaha 3. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, George Levene, M.D., Massachusetts Memorial Hospitals, Boston. Meets monthly on third Friday at Boston Medical Library.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary-Treasurer*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meetings quarterly in Concord.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Raphael Pomeranz, M.D., 31 Lincoln Park, Newark 2. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark.

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, J. Daversa, M.D., 603 Fourth Ave., Brooklyn. Meets fourth Tuesday of each month, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary-Treasurer*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meetings in January, May, and October.

LONG ISLAND RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening, October to May, at 8:45 P.M., in Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Wm. Snow, M.D., 941 Park Ave., New York 28.

QUEENS ROENTGEN RAY SOCIETY. *Secretary*, Jacob E. Goldstein, M.D., 88-29 163rd St., Jamaica 3. Meets fourth Monday of each month.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Ralph E. Alexander, M.D., 101 Medical Arts Bldg., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Charles Heilman, M.D., 1338 Second St., N., Fargo.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Carroll Dundon, M.D., 2065 Adelbert Road, Cleveland 6. Next meeting at annual meeting of the State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Paul D. Meyer, M.D., Grant Hospital, Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Seneca Hotel, Columbus.

CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Eugene L. Saenger, M.D., 735 Doctors Bldg., Cincinnati 2. Meets last Monday, September to May.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Merthyn A. Thomas, M.D., 10515 Carnegie Ave., Cleveland 6. Meetings at 6:30 P.M. on fourth Monday, October to April, inclusive.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. E. Brown, M.D., 21st and Xanthus, Tulsa 4. Meets in October, January, and May.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Boyd Isenhart, M.D., 214 Medical-Dental Bldg., Portland 5. Meets monthly, on the second Wednesday, at 8:00 P.M., in the library of the University of Oregon Medical School.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Arthur Finkelstein, M.D., Graduate Hospital, Philadelphia. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, R. P. Meader, M.D., 4002 Jenkins Arcade, Pittsburgh 22. Meets second Wednesday of each month at 6:30 P.M., October to June.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., Lincoln Clinic, Lincoln, Nebr. Next meeting in Denver, Colo., Aug. 18–20, 1949.

South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer* Marianne Wallis, M.D., 1200 E. Fifth Ave., Mitchell. Meets during Annual Session of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. Meetings second Tuesday of each month at University Center.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frére, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth 2. Meetings on third Monday of each month in Dallas in the odd months and in Fort Worth in the even months.

HOUSTON X-RAY CLUB. *Secretary*, Curtis H. Burge, M.D., 3020 San Jacinto, Houston 4. Meetings fourth Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting Feb. 3–4, 1950, in Dallas.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., Norfolk General Hospital, Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Homer V. Hartzell, M.D., 310 Stimson Bldg., Seattle 1. Meetings fourth Monday, October through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Theodore J. Pfeffer, M.D., 839 N. Marshall St., Milwaukee 2. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day meeting in May; one-day with State Medical Society, September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursdays 4 P.M., September to May, Service Memorial Institute, Madison 6.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542, Santurce, Puerto Rico.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, E. M. Crawford, M.D. Associate Honorary Secretary-Treasurer, Jean Bouchard, M.D. *Central Office*, 1535 Sherbrooke St., West, Montreal 26, Quebec. Meetings in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origéne Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA, *General Secretary*, Dr. Dionisio Pérez Cosío, Marsella 11, México, D. F. Meetings first Monday of each month.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

The Musculoskeletal System

Gynecology and Obstetrics

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Diploic Epidermoid and Extra-Dural Pneumatocele: Cranial Defects and Deformity. Joseph E. J. King. Ann. Surg. **127:** 925–952, May 1948.

This paper consists of two parts, which might well be two separate articles, since the only thing which diploic epidermoid and extradural pneumatocele have in common is the fact that they can be easily diagnosed on plain skull films.

Diploic epidermoids or cholesteatomas produce irregular defects in the skull bones, with scalloped or "geographic" borders but with a characteristic dense line around the outer limit. Some grow outward and cause only thinning of the inner table of the skull, but the majority grow inward, destroying the inner table, sometimes occupying huge areas, causing marked displacement of the brain. The bone is not invaded, but the lining membrane must be completely removed or cauterized to prevent recurrence. Growth is very slow.

The differential diagnosis is based on the sharply defined dense white scalloped margin. Neoplastic destruction does not show a dense line at the periphery, while an inflammatory lesion shows reaction but not the sharply defined zone of uniform thickness which is seen in cholesteatoma.

Two successfully treated cases are presented, with excellent reproductions of the films. One of the lesions was nearly 10 cm. in diameter and 7.5 cm. thick.

The second half of the paper concerns extradural pneumatocele without perforation of the skull. Pneumatocele complicating fractures and gunshot wounds is well known but the spontaneous accumulation of air in the extradural space, with the skull intact, as reported here, must be very rare.

Two cases are presented. In the first, in which operation was performed, the air reached the space between the skull and dura from a small fistulous opening into the middle ear. The patient had had both otitis media and a head injury previously, either of which may have been the cause. The presence of the air resulted in a very bizarre erosion of the skull from within, with sharply defined margins and an appearance much like coral rock. Describing the lateral view, the author writes: "The area is trabeculated throughout, denser portions appearing lighter and thinner areas darker. Some areas are almost black. The margins are somewhat scalloped, and the scallops are smaller than those seen in films of epidermoids. They are also more numerous. The margins of the scallops are more distinct at some points and less distinct at others. No point about the margin presents the fuzziness seen in cases of malignancy. . . . . The shadow cast by the base of the petrous pyramid is very dense with a small external opening of the auditory canal. The posterior portion of the mastoid shows no cells or else they are lost in the involved area. There is distinct destruction of the posterior portion of the base of the petrus. The part which remains presents a concave surface. The eroded area 'saddle-bags' the petrous ridge and dips into both middle and posterior fossae. In the middle fossa the destructive process involving the squama reaches down to the level of the floor of the sella. In the posterior fossa it extends as far as the base of the skull."

In the anteroposterior view, the "dark area" was seen to extend from high on the cranial vault at a point about 5.2 cm. from the mid-line, downward into the middle fossa below the petrous pyramid, a distance of 15 cm. There was some destruction of the base of the petrus and this section was not so dense as that of the opposite side. The dark area was more massive above and measured 6 cm. in thickness from the inner table of the skull. The remainder of the skull showed quite white by contrast.

This roentgen picture is quite unlike any other. It resembles most closely hemangioma of the skull but is not the same.

A second case resembling the first was subsequently seen and the diagnosis was made on the basis of the similar roentgen picture.

Recognition of the condition before operation is important, so that the fistula may be sought out and closed, as otherwise the air will reaccumulate.

Nineteen roentgenograms; 10 photographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Roentgen Changes Produced by Diffuse Torulosis in the Newborn. Edward B. D. Neuhauser and Arthur Tucker. Am. J. Roentgenol. **59:** 805–814, June 1948.

Three cases are reported of torulosis of the newborn. All showed cerebral calcification similar to that reported in toxoplasmosis. Much of the calcification was scattered on the surface in the parasagittal areas, but some was seen deep within the brain substance. In each case the calvarium appeared larger than normal, but with normal bone architecture, although in one case the bones of the base seemed more dense than usual.

Numerous other clinical findings were noted but no other calcification. One case showed enlargement of the liver and spleen and one a pneumonitis with focal atelectasis. Autopsies were obtained in all 3.

Eighteen illustrations, including 9 roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Intracranial Pneumocephalus: Report of a Case. David C. Straus. Arch. Surg. **56:** 766–784, June 1948.

Intracranial pneumocephalus may be subdural or intracerebral. The former is commonest, but has been reported only after fracture of the frontal sinus. The latter may occur if the dura and arachnoid membrane are torn and the cerebral cortex is broken simultaneously with fracture of the frontal or ethmoid sinus, provided adhesions first form between the brain and dura, walling off a fistulous tract and preventing the air from reaching the subdural space. This same process may also lead to intraventricular collections of air. Subarachnoid collections are seen only in the vicinity of the cisterna magna, as a result of fractures involving the sphenoid or posterior ethmoid cells. Mixed varieties frequently occur. Non-traumatic or spontaneous pneumocephalus follows erosion of the bone between the sinuses and the intracranial surface, usually as a result of infection or tumor.

The two most characteristic symptoms of pneumocephalus are cerebrospinal rhinorrhea and evidence of heightened intracranial pressure. Headache increased by sneezing is an important sign. While a diagnosis can usually be made from the history and clinical symp-

toms, roentgenologic study is the one infallible diagnostic measure. The author does not discuss this phase of the subject, but refers to a paper by Eaglesham (Brit. J. Radiol. **18:** 335, 1945. Abst. in Radiology **47:** 304, 1946). If there is question as to the presence of cerebrospinal fluid in the nasal discharge, it may be settled by subarachnoid injection of 1 c.c. of indigo carmine solution into the spinal canal, which stains the cerebrospinal fluid a bluish green.

Treatment may be either operative or non-operative. If infection results from the pneumocephalus, it is almost invariably fatal. A case successfully treated without operation is reported in detail.

Eight roentgenograms; 4 photographs.

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Skull Roentgenograms of Interest to the Otolaryngologist. Francis H. McGovern, G. Slaughter Fitz-Hugh, and George Cooper, Jr. Ann. Otol., Rhin. & Laryng. **57:** 387–396, June 1948.

The object of this paper is to review some pathologic conditions and congenital anomalies of the skull and intracranial contents which can be recognized as abnormal by the otolaryngologist in routine roentgenograms of the sinuses. The facts elicited are well known and provoke no discussion. The paper is of value primarily to the man doing occasional x-ray work and without proper opportunities to refer cases to radiologists.

Twenty-two roentgenograms.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Roentgen Examination of the Lingual Tonsil. Sölve Welin. Acta radiol. **29:** 546–548, June 30, 1948.

The lingual tonsil consists of a fine fibrous network containing lymphoid tissue scattered over the pharyngeal part of the tongue. It may be involved by acute infectious processes, but chronic inflammation and hypertrophy are more common. In the postero-anterior film small enlargements appear as defects in the contrast medium at the bottom of the vallecula; in the lateral view they are seen as small polypoid tumors between the base of the tongue and the epiglottis. In the case of larger lingual tonsils, the plain lateral film shows a rounded shadow projecting backwards from the base of the tongue; with contrast medium, a lobulated surface is demonstrable in both the postero-anterior and lateral projection.

Lingual goiter and malignant tumors require differentiation. In the former, the usual picture is that of a smooth rounded mass in the pre-epiglottic region with relatively large blood vessels. Occasionally there may be an area of calcific density in the soft-tissue shadow. The hyoid bone may be displaced distally. Irregularity of the rounded shadow is suggestive of a malignant growth, but definite diagnosis should be made only after biopsy.

Five roentgenograms. EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospital

Moniliasis of the Larynx: Report of Two Cases. Claude C. Cody. Ann. Otol., Rhin. & Laryng. **57:** 371–376, June 1948.

The importance of the diagnosis of moniliasis of the larynx resides in its differentiation from diseases with a far higher incidence, such as cancer, tuberculosis, syphilis, and acute simple laryngitis. Two cases of monilial infection of the larynx are here reported. In one, persistent hoarseness, referred pain to the ear, dysphagia, cough, and a tumor on a fixed vocal cord, suggested the possibility of cancer, tuberculosis, or syphilis. The x-ray film of the chest showed bronchovascular mottling of both lungs, suggestive of a monilial infection, but no evidence of tuberculosis or cancer. The sputum examination was negative for *B. tuberculosis*, but showed a profuse amount of *Monilia albicans*. Serologic tests for syphilis were negative. A biopsy showed only inflammatory tissue.

The second patient had an acute laryngitis. The x-ray film was reported to be negative for chronic pulmonary tuberculosis. Sputum examination showed no tubercle bacilli but *Monilia albicans* was present in abundance.

Four illustrations, including 1 roentgenogram.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

THE CHEST

Roentgen Studies of Thoracic Tumors. Howard P. Doub. Pennsylvania M. J. **51:** 968–975, June 1948.

Roentgen examination is of decisive importance in almost all thoracic tumors. It is useful in determining the location of the tumor, its point of origin, and its character—inflammatory, benign, or malignant.

Tumors of the chest wall may be either benign or malignant. The benign bone tumors are osteochondromas (which are the most common), giant-cell tumors, and osteomas. Their characteristics are the same as in other portions of the body. The benign soft-tissue tumors of the chest wall include fibromas, which usually produce shadows of homogeneous density, the lipomas seen as circumscribed areas of decreased density, and the angiomas which may show small areas of calcification similar to phleboliths in other portions of the body. These tumors grow slowly and cause few symptoms unless they become large.

The malignant tumors of the chest wall are the chondrosarcoma, osteochondrosarcoma, fibrosarcoma, myxoangiosarcoma, osteosarcoma, and metastatic lesions. They have a relatively short history. The roentgen signs are those of similar tumors elsewhere, but they may be complicated by pleural and pulmonary involvement with effusion and, in some cases, fixation of the lung to the chest wall.

Most of the mediastinal tumors are due either to primary or secondary lymph node involvement. Accurate diagnosis cannot be made from the roentgen examination alone.

Hodgkin's disease usually presents a bilateral shadow, lymphosarcoma unilateral. The tumors usually lie anteriorly and do not pulsate on fluoroscopic examination. They are generally clearly outlined unless secondary lung involvement makes their contours hazy. In many cases superficial nodes are involved and can be removed for study. The blood picture will usually establish the diagnosis in the leukemias. In some cases a clinical test of irradiation therapy will help in making the diagnosis. Lymphosarcoma regresses rather promptly with moderate doses of x-ray.

The benign tumors of the mediastinum are not common. The dermoid cyst can be diagnosed if it contains

teeth or bone. A rounded dense shadow, if it occurs in the posterior mediastinum, is likely to be a ganglioma or neurofibroma. Cystic goiter can usually be identified by its position.

Benign tumors of the lung and bronchi are rare, the chondroma being the most common. This is a well circumscribed, slow growing tumor, which may cause symptoms by obstruction of the bronchus. Bronchoscopic examination is of value in making a diagnosis. Cysts may be diagnosed by taking films in various positions to show a fluid level.

Primary carcinoma of the lung is of two main types: the hilar type, originating in the main bronchus or in one of the larger branches, and the lobular type, arising in the periphery of the lung or from the terminal bronchi, and usually appearing as a solitary tumor nodule.

The diagnosis of primary carcinoma must depend upon the history, physical examination, bronchoscopy and roentgen examination. The roentgen signs are varied and are not always pathognomonic. An area of increased density near the hilum, spreading out peripherally and having either a circumscribed border or a fuzzy indefinite outline, is the most common finding. It may be so small as to be easily missed, or so large that it constricts the bronchus causing obstructive emphysema or atelectasis. Secondary infection and pneumonitis eventually occur, and many times an abscess may form. The parenchymal type of carcinoma shows a more localized area of increased density near the periphery, and may involve the chest wall by extension. The superior sulcus tumor (Pancoast tumor) involves the apex, and may erode the ribs or dorsal spine.

Primary pulmonary sarcoma is rare and is indistinguishable from carcinoma.

Metastatic carcinomas are generally of two types, nodular and diffuse lymphangitic. Multiple circular shadows with rather fuzzy outlines are suggestive of carcinoma, while sarcomatous metastases give more clear cut rounded outlines. The diffuse lymphangitic type of metastasis may simulate a variety of conditions. The roentgen findings consist of an extensive accentuation of the linear markings, usually extending out from the hilum. There may be enlargement of the hilar nodes and, in addition, many small nodules which have somewhat the appearance of miliary nodulation.

The benign pleural tumors in their early stages show a round or oval shadow which is sharply circumscribed and of uniform density. They are slow growing, and may almost fill the chest cavity. Primary malignant tumors of the pleura are unusual. The endothelioma, which is the most common, may first appear on roentgen examination as a thickening of the pleura; later, fluid develops, rapidly reaccumulating after aspiration. Withdrawal of fluid and the introduction of air may outline the tumor nodules.

The most common tumors of the pleura are metastatic being first manifested by pleural effusion. It is only later that the actual tumor nodules are seen.

Primary tumors of the diaphragm are rare, and sometimes the lung must be collapsed in order to determine whether the diaphragm or the lung is involved. Fat pads and cysts make differential diagnosis difficult.

Shadows are sometimes seen in the chest which do not conform to the typical appearance of tumors. A solitary rounded shadow may be produced by a pigmented nevus of the skin, which will be disclosed by a simple chest inspection. Localized erosion of the ribs may be secondary to coarctation of the aorta. Shadows in the mediastinum may be of non-tumorous origin. Cardiospasm may cause an enlargement of the esophagus, which will give the appearance of a tumor. In this instance, a history and fluoroscopic study with barium will establish the diagnosis. A diaphragmatic hernia may appear as a tumor, and its diagnosis may also be determined by fluoroscopy with barium. Aneurysms may be diagnosed by fluoroscopic examination, but there are instances in which there is no pulsation present, and the pressure from the aneurysm may cause changes in the lung. Mediastinal lymphadenopathy may be due to tuberculosis rather than tumor.

Single circumscribed areas most often—but not always—represent benign lung tumors. They may also be due to mycotic infection. Miliary nodules of carcinomatosis may simulate miliary tuberculosis, mycotic infection, sarcoidosis, and pneumoconiosis.

JOSEPH T. DANZER, M.D.
Oil City, Penna.

Carcinoma of the Trachea. Clarence W. Engler. Ann. Otol., Rhin. & Laryng. **17:** 429–444, June 1948.

Two cases of carcinoma of the trachea are reported. In the first, the tumor was definitely primary in the trachea. In the second, the carcinoma was so far advanced when the patient was first observed that it could not be definitely determined, even at autopsy, whether the lesion arose primarily in the trachea or esophagus.

Case I: A man, aged 47 years, complained of dyspnea, wheezing, incessant tickling in the throat, and continuous coughing for eight weeks. During the last week, the cough had been productive of small amounts of blood and frothy sputum. Fluoroscopic and radiographic examination of the chest showed a sharply circumscribed spherical tumor, about 6 cm. in diameter, in the upper mediastinum, just to the right of and behind the ascending arch of the aorta, lying in intimate relationship with the esophagus, which it compressed, and with the trachea at its bifurcation. The lungs appeared clear and well aerated, indicating absence of bronchial obstruction. Tracheoscopy disclosed a large fungating mass extending over the posterior wall of the trachea, at the bifurcation. The tumor bled freely and was quite friable. Histologic examination showed it to be a poorly differentiated squamous carcinoma.

A course of roentgen irradiation was administered in thirty-four days, a total tumor dose of 4,300 r being given through six fields, each 6 to 8 cm. in diameter, with the central ray directed toward the tumor by fluoroscopic localization. Two fields were irradiated daily, with the following factors: 200 kv., 0.5 mm. copper filtration, 1.0 mm. copper half-value layer, 70 cm. distance. Symptoms were relieved and the tumor disappeared.

A year and nine months later there was a recurrence of coughing and a slight depression of the esophagus in the posterior mediastinal region was demonstrable roentgenographically, but no distinct soft-tissue mass could be identified. Bronchoscopy, however, revealed a mass just below the subglottic space on the anterior wall of the trachea. A fungating tumor was also present at the site of the original lesion. A second course of roentgen treatment was in progress at the time of the report.

The failure to demonstrate the recurrent tumor in this case on routine roentgen examination points to the

necessity of special radiologic methods to reveal lesions of this type. Oblique and lateral views and use of a contrast medium in the esophagus, plus fluoroscopic examinations with the patient changing positions, coughing, and swallowing, may be necessary.

Case II: A woman, aged 66, was admitted on June 14, 1947, for a tracheotomy for extreme respiratory distress. Tracheal obstruction presented the passage of the tracheotomy tube, and bronchoscopy revealed a tumor almost totally occluding the trachea. A large portion of the trachea was exposed but the tumor extended too far downward to make its total removal possible. A postero-anterior roentgenogram of the chest showed a pronounced widening of the upper mediastinum. On the lateral view, the esophagus appeared distorted and greatly constricted at the site of the lesion in the trachea. Histologic examination of tumor tissue removed from the trachea showed it to be a partially differentiated squamous-cell carcinoma.

Roentgen therapy was instituted, but the course was steadily downward and death occurred three months after the original examination. Autopsy showed a carcinoma involving the trachea and esophagus.

Most patients with tracheal tumors die as the result of respiratory failure because of obstruction. Any tumor which grows large enough to obstruct the tracheal airway will prove fatal no matter how benign it may be histologically. Since this is so, and since some of the benign tumors apparently are potentially malignant, bronchoscopy is indicated in all patients whose symptoms suggest a tracheal obstruction, for prompt and radical removal of a possible tracheal tumor. In the majority of cases of carcinoma of the trachea, the metastases are only regional. In some reported cases in which the tumors were of high-grade malignancy, death occurred from respiratory obstruction before metastasis or extratracheal extension had occurred.

Six roentgenograms; 1 photomicrograph.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Carcinoma of the Lung. Adrian Lambert. Am. J. M. Sc. **215:** 1–12, January 1948.

The author reports a series of 70 cases of carcinoma of the lung explored surgically for possible removal, comprising 20 per cent of all cases of carcinoma of the lung seen in about seven years. The 25 cases resected represent an operability of only 7.2 per cent. As a result of operative experience, the attitude is tending more and more toward early exploration of cases with only suggestive x-ray findings and with possibly no other evidence of disease. Frequently, exploration was done where biopsy was negative and bronchoscopy was suggestive. The importance of bronchoscopy is paramount as a single diagnostic procedure, but the resectability depends on early exploration of cases with suggestive x-ray changes even though bronchoscopic findings are negative. The operability cannot be predicted by bronchoscopy except that surgery is contraindicated in cases where the tumor can be seen to invade the trachea or extend to the opposite side. Age itself was not considered a contraindication to exploration.

Comparison of the symptomatology in those cases which were resectable and in those which were nonresectable was of no help in evaluating the resectability.

If a patient with a carcinoma can stand the loss of pulmonary parenchyma, a pneumonectomy is the operation of choice. If the disease is well localized to one lobe and the hilar nodes are negative, lobectomy may be the operation of choice. If thoracoplasty is to be performed, it should be done at an early date, before pleural thickening has developed.

The rate of resectability of adenocarcinoma was high, and was closely associated with negative biopsy. Because the squamous-cell carcinomas were slower growing, the longevity in this group was greatest.

It was felt that irradiation was useless in a large percentage of the patients. It is often impossible to recognize the involvement beyond the lung by x-ray alone.

Seven tables.

BENJAMIN COPLEMAN, M.D.
Perth Amboy, N. J.

Myoblastoma of the Bronchus. Alvin R. Kraus, Perry J. Melnick, and Joseph A. Weinberg. J. Thoracic Surg. **17:** 382–389, June 1948.

Abrikossoff in 1926 described a type of neoplasm which occurs chiefly in immediate relation to striated muscle and which is composed of its embryologic precursors, the myoblasts (Virchows Arch. f. Path. Anat. **260:** 215, 1926). Many of these tumors have been described in all parts of the body, but only one case has been previously reported in the bronchus.

The authors present in detail a case occurring in a 48-year-old male. His chest symptoms began nine years earlier with pneumonia, followed by several bouts of pneumonitis, with subsequent empyema at the right base, for which a rib resection was done. A short time later, the right lower lobe was removed for bronchiectasis followed by a fistula. This continued until the patient's last admission, when the right upper and middle lobes were removed. Numerous bronchoscopies were done, showing a mass in the right main bronchus. Repeated biopsies were taken, with an eventual diagnosis of myoblastoma. The mass after removal measured $6 \times 5 \times 3.5$ cm.; it filled and distended the main bronchus, breaking through the bronchial wall in one small area. The tumor was benign. Death occurred on the eleventh postoperative day, probably from a pulmonary embolism.

There is a brief discussion of the embryology of this tumor as well as a short review of the literature.

Two planigrams; 1 photograph; 1 photomicrograph.

HAROLD O. PETERSON, M.D.
University of Minnesota

Significance of Triangular Hilar Shadows in Roentgenograms of Infants and Children. Rolfe M. Harvey and Ralph S. Bromer. Am. J. Roentgenol. **59:** 845–852, June 1948.

A triangular shadow of increased density is seen occasionally in roentgenograms of infants, less often in young children, projecting from the region of the hilum of the right lung, less frequently from the left. This shadow has a sharp lateral margin which ends in an inferior angle, usually less than 90 degrees, and is either in close relation to, or merges with, the interlobar fissure marking. It is rarely found simultaneously on both sides. The density in the lateral view is located in the anterior mediastinal space.

In a consecutive series of 300 chest examinations in a children's hospital, 9 showed these triangular hilar shadows (8 on the right, 1 on the left). Most of them were attributed to enlargement of the thymus. All eventually disappeared and there were no deaths.

Mediastinal pleurisy, pneumonic consolidation of the medial part of the upper lobe, atelectasis, and enlarged lymph nodes can also produce this picture.

Fourteen roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Contribution on the Differential Diagnosis of Multiple Nodular Shadows in the Lungs. H. G. Horst, H. Legler, and V. Buchtala. Schweiz. med. Wchnschr. **78:** 543–545, June 5, 1948. (In German.)

The first case reported is that of a 26-year-old man who fell into the water and was rescued unconscious. Sixteen hours after he was admitted to the hospital a chest film showed miliary pulmonary shadows. He made a prompt recovery and a film seventeen days later showed complete clearing of the shadows.

A second patient was an epileptic, brought in because of hemoptysis. The initial x-ray examination showed miliary pulmonary shadows; one hour later the patient had a seizure, which was followed by acute pulmonary edema. He gradually recovered, and eight days later his chest film was negative.

In both patients the miliary nodulation affected the bases but spared the apices, and the nodules varied in size from submiliary to lobular. The appearance was attributed to an acute pulmonary edema, and the authors advocate the employment of x-rays for the early diagnosis of "latent" edema of the lungs—*i.e.*, cases of injury or disease of such nature that the presence or development of edema might logically be anticipated.

Two roentgenograms. LEWIS G. JACOBS, M.D.
Oakland, Calif.

On Lung Changes in Acute General Dermatitis. Nils Frostberg. Acta radiol. **29:** 493–502, June 30, 1948.

Two cases of an acute general exanthema with transitory lung changes are described. The chest films showed a slight discrete pulmonary edema similar to that seen in allergic conditions. The author's conclusions parallel those of workers in this country who claim that the lung may be an allergic "shock organ," just as other tissues.

Six roentgenograms.

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospital

Functional Pulmonary Changes Following Bronchography. William A. Zavod. Am. Rev. Tuberc. **57:** 626–631, June 1948.

Iodized oil may be retained in the lungs for long periods following bronchography. The study reported in this paper was made to determine if this residual oil caused any impairment in pulmonary function. The investigation was carried out upon 50 unselected patients who had diagnostic bronchograms during their hospitalization. Spirometric studies were performed each day for five days and the bronchogram was obtained on the sixth day. Complete filling of the bronchi to both lungs was done, using 20 c.c. of lipiodol. Spirometry was carried out one hour after completion of the bronchography and daily thereafter until the results reached the prebronchogram levels on two successive days. Ninety per cent of the patients showed loss of pulmonary function and decrease in pulmonary volume one hour after bronchography. The highest average loss was in the reserve air. This loss was recovered gradually and a return to prebronchogram level occurred within a maximum of five days.

Two tables; 2 graphs. L. W. PAUL, M.D.
University of Wisconsin

Some Observations on the Roentgen Diagnosis of Non-Opaque Foreign Bodies Aspirated into the Bronchi. Sölve Welin. Acta radiol. **29:** 529–535, June 30, 1948.

Non-opaque foreign bodies in the bronchial tree are often diagnosed on the basis of indirect symptoms and signs, mainly due to valvular obstruction and atelectasis. To increase the certainty of roentgen diagnosis, the author obtains postero-anterior and oblique views, after fluoroscopy, using an increase in kilovoltage and time. These will often reveal the foreign body in relief against the air column of the bronchus.

After direct roentgen demonstration of a foreign body, the indication for bronchoscopy is absolute. In other cases the indications are relative. Where the symptomatology suggests the presence of a foreign body and none can be visualized, one must think of the possibility of mucosal swelling, primary or secondary to an already expelled foreign body, or the presence of multiple peripheral foreign bodies.

In cases of atelectasis, the value of being able to determine the site of interruption of the air column is obvious, and occasionally the character of the foreign body may be suggested. Tomography has been attempted, but the long exposure time prevents satisfactory results. Several case histories are included.

Six roentgenograms; 1 table.

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospital

Bronchopulmonary Hypogenesis. Clinical and Roentgenologic Features in the Adult, with Long Follow-up Observations. Louis Schneider. Am. J. M. Sc. **215:** 665–670, June 1948.

Two cases of bronchopulmonary hypogenesis—*i.e.*, a partially developed bronchopulmonary system on one side and normal lung and bronchi on the other—are reported. The patients were young Negro adults, followed for more than fifteen years. In general, patients with this developmental anomaly show no respiratory difficulty at birth, indicating that compensation has occurred during intrauterine development. External symmetry of the chest is well maintained. There is, however, a tendency to repeated pneumonias, and, as the patients grow older, they may complain of exertional dyspnea, bloody sputum, or wheezing.

The roentgenogram shows abnormal density of one side of the chest, with displacement of the heart and mediastinum to that side. The bronchogram shows the deviation of the bronchial tree and abnormal branching of the bronchi on the affected side, having a hypogenetic appearance. Some of the bronchi may end blindly. There is no evidence of bronchiectasis.

Six roentgenograms. PAUL W. ROMAN, M.D.
Baltimore, Md.

Diagnosis of Unilateral Total Lung Obscuration of Rare Etiology: A Case of Congenital Left-Sided Pulmonary Atelectasis with Saccular Ectasia of the Large Bronchi. H. R. Stettbacher. Schweiz. med. Wchnschr. **78:** 586–588, June 19, 1948. (In German.)

The report concerns a 68-year-old woman whose chest roentgenogram showed a homogeneous density occupy-

ing the entire left hemithorax. The mediastinum was displaced into the left chest. Possibilities considered in the differential diagnosis included lung or pleural carcinoma, tuberculosis, chronic pneumonia, pleuritis, progressive fibrosis, etc. Bronchography demonstrated a congenitally hypoplastic left lung occupying the apex of the left thorax only, down to the level of the second rib, with gross saccular bronchiectasis of its bronchi; the middle lobe of the right lung was rotated forward into the left chest, and its upper and lower lobes filled the right chest. The heart lay posteriorly in the left paravertebral region. The entire deformity was thought to be due to congenital malformation.

Five roentgenograms. LEWIS G. JACOBS, M.D.
Oakland, Calif.

Spreading Suppurative Pneumonitis. H. E. Counihan. Irish J. M. Sc., pp. 270–272, June 1948.

A case of "spreading suppurative pneumonitis" is presented. This case falls into the group of chronic pulmonary sepsis first clearly described by Holmes Sellors in 1946 (Thorax **1:** 146, 1946). Males of middle age are commonly affected. The onset is not characteristic but relapses and remissions are typical. The symptoms are fever, cough with copious sputum, sweating, prostration, chest pain, dyspnea, and hemoptysis. Physical signs are equivocal but x-ray examination shows consolidation, not segmental, but spreading in a creeping fashion by direct extension, with healing of areas primarily involved. The right lung is commonly affected and spread to the opposite lung is rare.

Chemotherapy is ineffective, and drainage useless. If spontaneous cure does not occur, resection may be tried. The prognosis is poor.

In the case reported here, the diagnoses were successively pneumonia, lung abscess, a malignant neoplasm, and finally "spreading suppurative pneumonitis." The bronchogram was interesting. There was generalized fusiform bronchiectasis with several small intercommunicating cavities with multiple bronchial openings.

Pneumonectomy was advised, but the patient refused surgery. A brain abscess developed and death occurred shortly thereafter.

Two roentgenograms. EDWARD E. LEVINE, M.D.
Dearborn, Mich.

Delayed Chemical Pneumonitis in Workers Exposed to Beryllium Compounds. Harriet L. Hardy. Am. Rev. Tuberc. **57:** 547–555, June 1948.

Thirty-six cases of pneumonitis apparently due to the inhalation of beryllium compounds are analyzed by the author. The patients had been engaged in the manufacture of fluorescent lamps. In most of the cases, there was a delay in onset of symptoms of from one month to four years from the last date of apparent exposure to the fluorescent powder. The development of the disease was gradual in all cases, most of the patients seeking medical advice because of weight loss and fatigue followed by gradually increasing exertional dyspnea with or without cough. The roentgenograms in the early stages suggested a "sand storm." Later there was an increase in hilar shadows and a diffuse reticular pattern on a granular background in the lung fields. Finally, small, distinct nodules appeared, described as a "snow storm." Other features noted in some cases were emphysematous changes at the apices, frequent mid-zonal distribution of the pulmonary densities, and four instances of small but distinct areas of pneumothorax.

The findings on physical examination have not been striking. Oxygen was useful in the treatment of the acutely ill patients. Other treatment was of little value in altering the course of the disease. The cases studied show this illness to be one of long duration. Six of the more severely affected individuals have died. Twenty-three patients are still functionally disabled; 3 are convalescent but well enough to work and 4 are free from symptoms although still showing characteristic roentgenologic changes.

Eight tables. L. W. PAUL, M.D.
University of Wisconsin

Pneumoconiosis of Coal-Miners. Parts I and II. C. M. Fletcher. Brit. M. J. **1:** 1015–1022, May 29, 1948; 1065–1074, June 5, 1948.

In extensive surveys of the problem of pneumoconiosis among coal miners in England and Wales, it was found that the amount of dust was the most important factor in the incidence (contradicting an old theory relating the incidence to the hardness of the coal). Mechanization markedly increased the number of cases because the amount of dust was increased. Methods of dust suppression are discussed briefly and the importance of considering whether the men charged with their operation will find them convenient and acceptable, since methods requiring too much trouble will be ignored.

A sociological survey showed that not many disabled miners were able to get satisfactory jobs because of their dyspnea and their lack of training in anything except mining.

The reticular pattern of early cases of silicosis can apparently be produced by pure coal dust (since it was observed in men engaged in loading coal into ships). However, the author has made no chemical analysis of postmortem lungs of this type. If the stage of reticulation is followed by focal emphysema, dyspnea and finally right heart failure occur. Other cases progress to the nodular stage and some go on to massive fibrosis. This latter complication is believed to be dependent upon an adequate silica content of the dust and to be due to the action of some infective agent, which may be tuberculous, although tuberculosis may often pursue an independent course in the presence of reticulation. It appears to develop as commonly in men removed from exposure as in those continuing to work underground.

Therapy consists mainly in prevention. Aluminum therapy is being tried but not much is expected of it. Breathing exercises sometimes help the dyspneic. Yearly mass surveys are recommended to find workers who should be advised to change occupation.

Six roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Clearing of X-Ray Shadows in Welders' Siderosis. A. T. Doig and A. I. G. McLaughlin. Lancet **1:** 789–791, May 22, 1948.

In 1945, the authors re-examined 15 of the cases of welders' siderosis described by them in 1936 (Lancet **1:** 771, 1936). All except 2 of the men had continued to work full time as welders, and all had remained in good health. One of the 2 had given up welding en-

tirely and the other had become a welding instructor. Of 7 men who showed no specific roentgenographic changes due to dust in 1936, 5 (average age 33.3 years, average welding exposure 14.8 years) still showed no abnormal changes; 1 (aged 35; 16 years welding) was now classed as suspicious; and 1 (aged 30; 15 years welding) showed a slight degree of reticulation. Two welders, classed as suspicious in 1936, showed in 1945 a definite picture of siderosis. Of 6 men who previously showed definite inhalation changes, 5 continued to do so. In 4 of these there was no change in the intensity of the abnormal x-ray shadows. In 1 case there was a considerable clearing of the shadows. The other man had a normal chest film where previously he had shown pronounced roentgenographic changes due to inhalation of dust. The latter 2 cases are reported in detail.

These cases provide evidence that the reticulation and nodulation of welders' siderosis is not necessarily permanent, and that the iron-oxide dust can be eliminated from the lung parenchyma after some years.

Effect of the Use of Calcined Alumina in China Biscuit Placing on the Health of the Workmen. A Field Study in a Group of Pottery Workers in North Staffordshire. A. Meiklejohn and W. W. Jones. J. Indust. Hyg. & Toxicol. **20:** 160–165, May 1948.

Powdered pure aluminum metal and certain forms of alumina (aluminum hydroxide) diminish the solubility of quartz *in vitro* and in living tissues. This has been demonstrated by numerous investigators, but whether inhalation of these substances is safe and of value in the prevention and treatment of silicosis in man is not yet established.

Until 1929 finely powdered calcined flint was used in the "placing" of chinaware for biscuit firing, and the biscuit placers suffered excessively from silicosis. After it had been proved that calcined alumina was a satisfactory substitute for the flint and that it had no deleterious effect on the health of the workmen, china manufacturers began to adopt alumina as the bedding medium. The particular variety of alumina used is corundum.

In 1946, 52 china biscuit placers who had previously been examined and who had many years exposure to flint and thereafter to alumina were still at work in the process. These men were re-examined clinically and a roentgenogram of the chest was taken in each case. In 27, no previous x-ray record was available.

This inquiry revealed that, although these workmen were daily exposed to finely powdered alumina in a greater intensity and over a considerably longer period than is possible with existing methods of aluminum prophylaxis and therapy, not only did new cases of silicosis occur but known cases advanced.

Three tables.

X-Ray Diffraction Analysis of Crystalline Dusts. Harold P. Klug, Leroy Alexander, and Elizabeth Kummer. J. Indust. Hyg. & Toxicol. **30:** 166–171, May 1948.

For the past ten years the standard procedure for the analysis of dusts for quartz has been the x-ray diffraction method developed by Clark and Reynolds (Ind. & Eng. Chem., Anal. Ed. **8:** 36, 1936). A recent advance in dust analysis is the use of the Geiger-counter x-ray spectrometer. The Geiger counter offers advantages in the determination of the intensities of the diffraction lines, and better resolution in cases of partial line superposition. It also offers a possibility of avoiding the use of an internal standard in some cases. At present the time required for making an analysis with it is about the same as with the older technic, but it is hoped that this may be shortened. Details of the adaptation of the internal standard technic of Clark and Reynolds to the recording Geiger-counter spectrometer are given. Above 10 per cent quartz the results are usually good to within ± 5 per cent of the absolute amount present. The problem of line superposition is also discussed.

Three tables.

Postthoracoplasty Pulmonary Hernia. Report of Four Cases. Irving Pine and Philip Morgenstern. Am. Rev. Tuberc. **57:** 580–586, June 1948.

Four cases of hernia of the lung following thoracoplasty are reported. All of the patients had pain in the shoulder or axilla. Roentgenograms revealed evidence of the hernia in three of the cases. An area of increased illumination was seen protruding beyond the normal confines of the thoracic cage, accompanied by incomplete or defective regeneration of the ribs. Normal lung markings could be identified, which helped to differentiate the hernias from lung cyst, cavitation, or bleb formation. Pulmonary hernia should be considered in the differential diagnosis of any post-thoracoplasty patient in whom persistent intercostal pain or pain in the axilla or shoulder occurs, together with a pulsion mass on the chest wall.

Five roentgenograms.

L. W. PAUL, M.D.
University of Wisconsin

Bronchiectasis Simulating Chronic Bronchitis. A Study of 46 Cases. J. D. H. Wearing. Lancet **1:** 822–824, May 29, 1948.

In a group of 211 men and 3 women serving in the Army, who had clinical findings suggesting chronic bronchitis, bronchoscopy revealed bronchiectasis in 46 (21 per cent). None of the clinical signs generally attributed to classical bronchiectasis was present.

Only by roentgenography is accurate diagnosis of bronchiectasis possible in the living subject. In certain forms of the disease a plain film is difficult to interpret correctly, but all types are generally obvious when bronchography is used. The present series included 31 cases of cylindrical, 3 of varicose, and 12 of saccular bronchiectasis. The appearances of cylindrical bronchiectasis in the plain film were not sufficiently characteristic for diagnosis in many of the cases.

Pneumonia is thought to play a leading role in the production of bronchiectasis. A past history of pneumonia was given by 56 per cent of the 46 patients with bronchiectasis, and by 32 per cent of the remaining 168 persons without bronchiectasis.

The length of time it takes for a reversible bronchiectasis to become irreversible is discussed. A case is reported in which the bronchi remained dilated for several months and then returned to normal.

Bronchiectasis Following Aspiration of Timothy Grass. Report of Eight Cases. Max G. Carter and Kenneth J. Welch. New England J. Med. **238:** 832–836, June 10, 1948.

This is a report of 8 cases of bronchiectasis following aspiration of timothy grass. The disease is seasonal,

having its onset in June or in July. The history is suggestive of a foreign body in the lung. Roentgenograms showed a pneumonitis, atelectasis, pneumonia, or lung abscess. In 7 of the cases, the process was on the right side. Bronchoscopy was usually resorted to, and in 3 cases the timothy head was recovered. In 4 cases, no foreign body was found even with multiple bronchoscopies.

One patient recovered completely following bronchoscopic removal of the timothy. In the remaining 7, lobectomy was required because of persistent pneumonitis.

Four illustrations; 1 table.

JOHN B. MCANENY M.D.
Johnstown, Penna.

Histoplasmin and Tuberculin Sensitivity in Relation to Pulmonary Calcifications Among University of Wisconsin Students. Helen A. Dickie and Elizabeth A. Clark. Ann. Int. Med. **28:** 1087–1093, June 1948.

Five thousand university students were surveyed by photofluorograms and tuberculin testing. Of these, 160 showed pulmonary calcification (or, much less frequently, non-calcified infiltration) with a negative tuberculin test. Of this number, 116 were tested with histoplasmin. On further study of the photofluorograms in this latter group, the original diagnosis of calcification was considered unjustifiable in 32. Of the remainder, 66 (including 5 with non-calcified infiltrates) were histoplasmin-positive, leaving 18 who reacted neither to tuberculin nor histoplasmin. Fourteen of this group were studied fluoroscopically, and 11 were discarded as without calcification, leaving only 3 who were actually negative to both tests. These results are in good agreement with those of Palmer and others who first studied this subject.

In a second study, comprising several groups of students, pulmonary calcification was found to be two to four times as frequent in histoplasmin reactors as in tuberculin reactors.

Four tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pulmonary Calcification in Twins. Gilbert Houston and W. A. Steiger. J. Pediat. **32:** 706–710, June 1948.

Two cases of pulmonary calcification in twins are reported. The first twin showed multiple small areas of calcification in the right lung field. In the second twin a small area of calcification was demonstrable in the left lower lung field. Both children had negative P.P.D. tuberculin tests in dilutions up to 0.005 mg.; both had negative coccidioidin skin tests; and both had positive histoplasmin tests of 1+ in 1:100 dilutions.

The symptomatology, physical signs, laboratory findings, pathology, mode of transmission, geographic distribution, and differential diagnosis of histoplasmosis are briefly discussed.

Two roentgenograms.

EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospital

Employment of Persons with Pulmonary Tuberculous Lesions. Marion W. Jocz, John J. Prendergast, and Carl C. Birkelo. Occup. Med. **5:** 496–505, May 1948.

This report describes the application of a planned program for the employment of persons with inactive pulmonary tuberculous lesions. It is based on experience with more than 300,000 examinees of the Chrysler Corporation during the years 1942 through 1946, inclusive. Specific analyses are presented, dealing with tuberculous persons in the Detroit area. The prevalence of active tuberculosis among the applications for industrial employment was 2.7 per thousand examinees, and of inactive tuberculosis, 7.3 per thousand examinees. The report shows that of each thousand persons with inactive tuberculosis, 12.5 will show active lesions during the course of ordinary industrial employment after an interval of 21.8 months.

Fifty-one persons whose initial films were diagnosed as showing no tuberculous signs, but in whom tuberculosis developed subsequently, worked an average of 28.2 months before their lesions were discovered.

The authors conclude that the employment of persons with certain types of inactive pulmonary tuberculous lesions is possible and practicable. The usual conditions of employment in a highly mechanized industry do not constitute a threat to the health of such persons or to their fellow employees.

Six tables.

Complications of Arrested Pulmonary Tuberculosis. Abel Froman. Illinois M. J. **93:** 306–314, June 1948.

A short discussion is presented of the differential diagnosis of emphysema, bronchiectasis, and bronchogenic carcinoma, complicating active or inactive pulmonary tuberculosis. Quite frequently the symptoms caused by the complication are thought to be due to a reactivation of the tuberculosis. Then valuable time is lost in the case of carcinoma, or time is needlessly spent in the sanatorium in the case of bronchiectasis or emphysema.

Cases are presented to illustrate the various complications.

Ten roentgenograms; 2 photographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Coexisting Pulmonary Coccidioidomycosis and Tuberculosis. Robert S. Study and Philip Morgenstern. New England J. Med. **238:** 837–838, June 10, 1948.

A 24-year-old Negro was admitted to the hospital in December 1945, a diagnosis of pulmonary tuberculosis having been made at a separation center. A chest film at that time showed infiltration at both apices and in the right third interspace anteriorly. During the war, the patient was on duty in southern California, but was not ill during this period.

On admission, x-ray examination showed minimal infiltration in both apices and an irregular angular shadow above the right clavicle, which was found to represent a small thin-walled cavity. Sputum examination and skin tests at this time were negative for tuberculosis and coccidioidomycosis.

The patient left the hospital in March 1946, but returned in June. Films on the second admission were essentially the same as before. Sputum and gastric washings were negative for tubercle bacilli; but on direct smear the sputum was found to contain spherules of *Coccidioides immitis*, and a complement-fixation test was positive. The patient was discharged in February 1947. In October 1947, he was again admitted because of hemoptysis and loss of weight. An x-ray examination at this time showed considerable enlargement of the cavity in the right apex. In addition, the upper third of the left lung was involved by a dense confluent type of

infiltration, with several poorly defined areas of radiolucence. Examination of sputum now showed acid-fast bacilli. Complement-fixation tests were strongly positive.

Since World War II, with many service men having had training in the southwestern United States, the possibility of coccidioidal pulmonary infection must be kept in mind. As this case shows, its coexistence with tuberculosis is quite possible.

Three roentgenograms.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Coccidioidomycosis in Veterans of World War II. H. E. Bass and A. Schomer. New York State J. Med. **48:** 1391–1393, June 15, 1948.

This article is a brief summary of the discussion elicited on the discovery of two cases of coccidioidomycosis in New York City in the Veterans Administration. It typifies the situation which must exist in many places outside known endemic areas of coccidioidomycosis. It also demonstrates that the radiologist must be aware of all possibilities when considering a chronic pulmonary lesion.

In the discussion, the authors bring out that approximately 6,000 members of the Armed Forces acquired this disease in a clinically recognizable form, and they further point out that there were probably a far greater number having a subclinical infection. Reference is made to an article by Fobus and Bestebreurtje (Mil. Surgeon **99:** 653, 1946), which is representative of the Army's experience with coccidioidomycosis.

S. F. THOMAS, M.D.
Palo Alto, Calif.

Primary Pulmonary Coccidioidomycosis. Case of Laboratory Infection in England. J. D. N. Nabarro. Lancet **1:** 982–984, June 26, 1948.

A case of primary pulmonary coccidioidomycosis in a laboratory worker in England is described. It is thought that the patient probably acquired the infection during manipulation of cultures seven days before the onset of the illness. This is the lower limit of the usually accepted incubation period.

The clinical and pathological features of the disease are reviewed. One roentgenogram is reproduced, showing small irregular patches of consolidation in both lungs.

Pulmonary Moniliasis. R. F. Robertson. Edinburgh M. J. **55:** 274–281, May 1948.

A fatal case of pulmonary moniliasis in a woman forty-two years of age is reported. At the age of twenty-one the patient had a severe bronchitis following a coryza. Thereafter she was subject to attacks of bronchial asthma, for which she was treated several times in the hospital. X-ray and sputum examinations were essentially negative. Seventeen years after the initial illness, the asthmatic attacks had lessened, but cough was worse and there was a copious mucopurulent sputum. Films of the chest showed fibrotic lesions in both upper lobes, with cavitation on the right side. Pulmonary tuberculosis was suspected, but in the course of two years constant observation, tubercle bacilli were never found in the sputum, though *Monilia albicans* was constantly present.

Three months before her final admission to the hospital, the patient became dyspneic on exertion, with edema of the legs, ascites, and a profuse diarrhea. Congestive heart failure secondary to lung disease was suspected, and it was for treatment of this that the patient was hospitalized. Cough and copious mucopurulent sputum with occasional hemoptysis had persisted undiminished. There was no valvular lesion of the heart. A roentgenogram showed diffuse changes involving both lungs, with fibrosis and cavitation in the upper zones, the combined appearance strongly suggesting tuberculosis in a fairly advanced stage. A provisional diagnosis of pulmonary tuberculosis was made. Twelve sputum specimens collected on successive days were negative, on direct examination and guinea-pig inoculation, for tubercle bacilli, but were positive for *Monilia albicans*. Blood culture, production of fixation abscess, serum agglutination, skin test, and therapeutic test were negative or unhelpful in establishing a diagnosis. The patient's condition became steadily worse. A rising blood urea, polyuria, and impaired renal function suggested that uremia was resulting from amyloid contracted kidneys.

At autopsy it was found that the upper and middle lobes of the right lung were almost replaced by several large cavities containing a small amount of fairly thick purulent fluid from which *Monilia albicans* could not be isolated. Similar but less marked changes were found in the left upper lobe. The remainder of the lungs showed congestion, chronic bronchitis and emphysema. There were no signs of tuberculosis on microscopic examination. The presence of amyloidosis was confirmed in the liver, spleen, and kidneys. The final diagnosis was bronchiectasis with amyloid disease.

The difficulties in making a diagnosis of moniliasis are discussed. The author concludes that it is doubtful if primary pulmonary moniliasis really exists. He believes it reasonable to postulate, however, that when secondary invasion of other pulmonary lesions is proved by bronchoscopic methods, *Monilia* may contribute to their chronicity.

No roentgenograms are reproduced.

Q Fever: Case Treated with Streptomycin. Leon Rosove, Harold E. West, and Albert G. Bower. Ann. Int. Med. **28:** 1187–1192, June 1948.

The case of Q fever recorded here is the first one to be reported as treated with streptomycin. The patient was severely ill but after forty-eight hours of treatment he began to improve rather rapidly. In twelve days he was discharged symptom-free. Previous treatment with sulfadiazine and penicillin had been without effect

Films reproduced showed consolidation of the left lower lobe with pleural reaction but no fluid. Resolution was rather slow but otherwise the appearance is essentially that of an ordinary lobar pneumonia.

Three roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Case of Infectious Mononucleosis with Atypical Pneumonia. Manuel Rodstein. Ann. Int. Med. **28:** 1177–1187, June 1948.

A patient of twenty-one had clinical and roentgen findings characteristic of primary atypical pneumonia. Roentgenograms of the lungs revealed progressive changes, through to almost complete resolution, also

characteristic of the disease. The blood findings, on the other hand, were those of an infectious mononucleosis and serologic tests for that disease were positive. The author suggests that the virus which caused the infectious mononucleosis produced the lung findings also.

[It is becoming more and more apparent that infectious mononucleosis can affect many systems and organs (skin rashes, hepatitis, etc.), so that the author's suggestion is a reasonable one. Probably many such cases occur and go unrecognized, since the pneumonitis can be present with almost no symptoms and also since infectious mononucleosis is so frequently overlooked.]

Four roentgenograms. ZAC D. ENDRESS, M.D.
Pontiac, Mich.

Mediastinal Emphysema. V. L. Collins. M. J. Australia 1: 614–618, May 15, 1948.

Mediastinal emphysema most commonly follows the rupture of pulmonary alveoli into the vascular sheaths of the lung, producing interstitial emphysema which spreads to the mediastinum. From there it may pass into the neck, the pleural cavity, or the retroperitoneal tissues. Thus subcutaneous emphysema, pneumothorax, or retroperitoneal emphysema may be an accompaniment of mediastinal emphysema.

Clinically the patient with mediastinal emphysema exhibits dyspnea and cyanosis. The chest movements are slight and the thorax is held in a position near full inspiration. Cardiac dullness is obliterated and heart sounds are distant. Engorgement of the neck veins and subcutaneous emphysema may be present. The diagnosis is established with the aid of a radiological examination. In the anteroposterior film there may be little to observe, though a linear shadow of air along either side of the superior part of the mediastinum or the heart borders may give a clue. The lateral view is therefore of primary importance. Characteristically air is seen just beneath the sternum. If the collection of air is large enough, the heart will be displaced posteriorly. Air may also be seen in the posterior mediastinum. The appearance must not be confused, however, with that of tension pneumothorax, when air will be seen beneath the sternum because of herniation of the anterior part of the mediastinum. In this condition, the anteroposterior view would accurately depict the situation.

Treatment depends upon the severity of the symptoms. In mild cases, simple measures, including the administration of oxygen, will usually be effective. In severe cases, or cases accompanied by pneumothorax, more drastic measures, such as aspiration of the trapped air or insertion of a cannula to allow the air to escape under water, may prove to be life-saving.

A case report is included and spontaneous mediastinal emphysema and pneumothorax in the newborn are briefly reviewed.

Four roentgenograms.

BERNARD S. KALAYJIAN, M.D.
Detroit, Mich.

Diagnosis of Fallot's Tetralogy and the Rationale of Its Surgical Treatment. Malcolm N. Allen. M. J. Australia 1: 729–730, June 12, 1948.

In infants under twelve months of age the diagnosis of the tetralogy of Fallot is rather difficult, since cyanosis may not be noticeable and the roentgen findings may be difficult of interpretation. Later cyanosis, clubbing of the fingers, polycythemia, and dyspnea become more prominent; a systolic murmur is heard over the base of the heart, with maximum intensity over the pulmonary area, and the boot-shaped cardiac silhouette—due to pulmonary atresia and hypertrophy of the right ventricle—is apparent on the roentgenogram.

The tetralogy of Fallot is by far the most common congenital cardiac lesion showing constant cyanosis which is compatible with survival at least to childhood. Several conditions, however, must be considered in the differential diagnosis before surgery is attempted. The *Eisenmenger complex* is the same lesion without pulmonary stenosis. Dyspnea and cyanosis are not so marked and the left cardiac border shows a bulge instead of concavity. The lungs are congested instead of showing diminished circulation. Obviously surgery is not indicated, since there is no pulmonary stenosis. *Transposition of the vessels* rarely permits survival beyond infancy. X-ray examination shows a rather characteristic silhouette with a narrow mediastinal shadow and a large globular heart. In the presence of a *gross septal defect* the cardiac shadow is of the enlarged spherical mitral type. *Pulmonary arteriovenous fistula* is a rare cause of cyanosis and clubbing but in this condition the cardiac findings are negative.

Surgical treatment of the tetralogy of Fallot does not effect a cure but does increase the oxygenation of the blood. A branch of the aorta or the aorta itself is anastomosed to the pulmonary artery to allow more blood to pass through the pulmonary bed. Dyspnea and cyanosis are greatly improved unless irreversible changes have taken place.

Two drawings.

[The surgical treatment of this anomaly is discussed in detail in two papers following that by Allen (C. J. Officer Brown: Surgical Treatment of Fallot's Tetralogy, pp. 731–733; R. H. Orton: Anaesthesia in the Surgical Treatment of the Tetralogy of Fallot, pp. 733–736.]

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Value of Roentgenography in the Diagnosing of Cardiac Disorder Following Rheumatic Fever. C. J. Hansson and Erik Jacobsson. Acta radiol. 29: 541–545, June 30, 1948.

Follow-up clinical and roentgen studies were made on 494 children who had suffered one or more attacks of rheumatic fever, to determine the condition of the heart. The time of examination was in no case less than four years after the disease's incipiency, and averaged 12.2 years. The x-ray findings were decisive in the diagnosis in 21.7 per cent of all cases, although the clinical-radiological correlation was frequently inconstant, as is seen by the following table (slightly modified from the original).

Definite organic heart defect	
Clinically and roentgenologically	121 cases
Not clinically but roentgenologically	5 cases
Clinically but not roentgenologically	150 cases
Neither clinically nor roentgenologically	116 cases
Uncertain organic heart defect	
Clinically, but with roentgenologic evidence of a defect	42 cases
Clinically, but without roentgenologic evidence	60 cases

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospital

Roentgen Diagnosis of Myocardial Infarction. L. Henry Garland and S. F. Thomas. J. A. M. A. **137:** 762–768, June 26, 1948.

The authors reviewed the roentgenkymographic and electrocardiographic records of 249 patients with suspected or known cardiac disorders. Findings were classified as "positive," "negative," or "questionable." The electrocardiograms were made with standard limb and 4F leads and interpreted by experienced cardiologists.

The two methods were in agreement in 201 cases (80.5 per cent). Eight cases had negative kymograms and positive electrocardiograms; 12 positive kymograms and negative electrocardiograms. The authors do not believe that the failure of correlation in these cases can be adequately explained. In 28 cases the findings were questionable with one method and definite with the other. It is felt that a combination of questionable results with one method and positive with the other indicates probable coronary infarct. A combination of questionable and negative is thought to indicate that there is probably no infarct.

Forty-seven of 58 cases of myocardial infarction had positive or probable kymographic findings. In 10 instances kymograms were positive while electrocardiograms were negative. In 5 of the 10 cases the clinical history and findings were typical, so that the diagnosis was not in doubt. The kymograms were decisive in establishing the diagnosis in 5 instances. Four of these cases are presented in some detail.

The method of roentgenkymography is explained, as is the interpretation of kymograms. Localized diminution or absence of pulsation, systolic expansion or paradoxic pulsation, and partial systolic expansion or pronounced diastolic irregularities are considered indications of myocardial infarction.

The authors believe kymography is indicated when the clinical diagnosis is in doubt or when electrocardiographic findings are equivocal or lacking. They also note that the kymogram is often more reliable in designating the severity of an infarct than is the electrocardiogram.

M. J. SHAPIRO, M.D.
University of Michigan

Diagnosis of Hypertrophy and Dilatation of the Right Ventricle. Mitral Stenosis and Cor Pulmonale. E. Attinger. Schweiz. med. Wchnschr. **78:** 395–402, May 1, 1948. (In German.)

Abnormalities of the right heart are less easily diagnosed than those of the left, and may progress even to terminal stages unrecognized. This discussion is pursued under three headings: roentgen findings, electrocardiographic findings, and clinical findings. Only the part dealing with roentgen findings is abstracted.

After a brief review of the roentgen anatomy of the heart, the author states that the direction of the stream of blood entering the right ventricle is toward the left and downward, while the exit stream passes almost directly upward. This results in *lengthening* of the right ventricle as the first change due to elevation of the blood pressure in the pulmonary artery. But since the heart cannot elongate, a bulging of the pulmonary conus and artery and rotation to the left result, producing the typical "mitral" configuration. With increase in the hypertrophy and dilatation, the next step is a widening of the cardiac shadow, which always takes place to the left. Widening to the right is very slight at this stage. The apex appears large and blunt. As enlargement progresses, the left border of the heart is more and more made up of right ventricle. The hypertension of the lesser circulation produces the roentgen sign of a broadened, sharply outlined, strongly pulsating hilus. In the right anterior oblique projection, the enlargement of the right chambers and the broadening and forward arching of the conus and pulmonary artery stand out, while in the left anterior oblique projection the elongation of the right ventricle and the marked rounding of the anterior border are prominent. The lateral projections show both the last of these findings and an increase in the thickness of the heart shadow.

Roentgen study of the lesser (pulmonary) circulation is necessary to estimate the loading of the right ventricle and the work capacity of the left. Two forms of overfilling of the lesser circulation can be distinguished. The first results from arterial hypertension in this system. Here the overfilling is limited to the arterial trunks, ending at the capillaries. There are found widening of the pulmonary artery and its root, broadening and deepening of the hilus shadow, and widening of the arterial shadows extending into the lung fields. A systolic expansion can be seen, especially in the hilar shadows. Especially important in distinguishing between this and passive congestion is the sharp contrast between the normally or excessively aerated lung and the overfilled vessels, with abnormally sharp demarcation of the vessel shadows. The second condition, passive pulmonary congestion, is a result of pressure elevation in the entire vascular bed of the lesser circulation, both arterial and venous. In this, the overfilling is especially noticeable in the central zones of the lungs. The hilar shadows are enlarged but show expansile pulsation only in very severe cases. If the condition has not progressed to the point of transudation into the alveoli, the lung appears normally aerated, but as edema supervenes, there is a progressive loss of luminosity of the lungs, most marked in the bases. Focal densities then appear, and these may be miliary in character. The appearance of a pleural exudate is also more common in right than in left heart disease. The opposite condition, a reduced filling of the pulmonary circulation, results from pulmonary stenosis or atresia. It is characterized by small hilar and vascular shadows.

Determination of the cause of the right-sided enlargement requires study of the left auricle; this is enlarged in mitral lesions, and in left heart failure of either infectious or vascular origin. The auricle tends to project beyond the right heart border as it enlarges, but this finding may not be shown by the anterior projection. The right anterior oblique and lateral views will show left auricular enlargement as a posterior projection of the cardiac silhouette into the retrocardiac clear space; contrast filling of the esophagus aids in demonstrating this, since it is also displaced by the enlarged auricle. Study of the right auricle requires the same views as study of the right ventricle. Increase in the shadow of the superior vena cava with an undulatory pulsation of the upper segment of the cardiac shadow is considered typical of enlargement.

Thirteen drawings.

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Aortic Pulmonary Anastomosis in Congenital Pulmonary Stenosis. Report of Forty-Five Cases. Willis J. Potts and Stanley Gibson. J. A. M. A. **137:** 343–347, May 22, 1948.

This article reports 45 cases in which congenital pul-

monary stenosis was treated by anastomosing the aorta directly to a pulmonary artery. This is the procedure originally reported by Potts, Smith, and Gibson (J. A. M. A. 132: 627, 1946) and made possible by the invention of a clamp which enables the blood to flow through the aorta while the anastomosis is performed.

The operation was undertaken 52 times. In 48 cases the preoperative diagnosis was tetralogy of Fallot. The classic clinical and roentgen findings of this condition are reviewed. Inability to exercise is considered the most important indication for operation. The authors emphasize that variations from the usual picture frequently occur. Failure to hear a murmur is felt to indicate pulmonary atresia rather than pulmonary stenosis. X-ray findings are particularly variable, and there may be no roentgen evidence of abnormality. Evidence of gross cardiac enlargement is felt to militate against a diagnosis of tetralogy of Fallot.

The preoperative diagnosis in four patients was tricuspid atresia. In 11 the roentgen findings suggested underdevelopment of the right ventricle and there was electrocardiographic evidence of left axis deviation, which findings made possible the differentiation from tetralogy of Fallot.

The technic of operation is reviewed and slight modifications recently developed are described.

Anastomosis was carried out in 45 patients, with 4 deaths, a mortality of 8.8 per cent. There was only one death among the last 34 patients in whom successful anastomosis was accomplished. Two deaths were due to cerebral thrombosis; one to bleeding into the hypothalamus; and one to postoperative shock and tension pneumothorax in a child with unrecognized apical tuberculosis. Forty-one patients have survived successful anastomosis; 39 are greatly improved, with loss of cyanosis and clubbing of fingers, improved nutrition, and increased exercise tolerance. Two patients, who still become cyanotic on exertion, have benefited moderately by the operation.

Postoperatively the greatest change has been in exercise tolerance. There has been an average increase of 30 per cent in oxygen saturation of arterial blood. In all cases there has been some increase in heart size, which appears to stabilize in one to two months. At the time this article was written, only a year had elapsed since the first operation, and the authors make it quite clear that evaluation of the total effect of the procedure is not yet possible. They particularly emphasize that the original malformation of the heart and great vessels is still present. Subsequent to surgery, 3 patients had marked cardiac enlargement, and it is feared they will soon go into cardiac failure. It is hoped that cardiac decompensation can be avoided as an early complication by obtaining an anastomatic lumen sufficiently small to obviate excessive strain on the already abnormal heart, while permitting sufficient flow of blood into the pulmonary circuit to relieve cyanosis.

Six patients were explored in whom pulmonary atresia rather than stenosis was found. In these cases the pulmonary artery was non-functioning and the lumen insufficient to permit anastomosis. Three of these children died postoperatively, and in general this group withstood thoracotomy poorly. One instance of Eisenmenger's complex, with adequate flow of blood through the pulmonary circulation, contraindicating anastomosis of the pulmonary artery and aorta, was discovered on exploratory thoracotomy.

Eleven illustrations, including 8 roentgenograms.

M. J. SHAPIRO, M.D.
University of Michigan

THE DIGESTIVE SYSTEM

Esophageal and Gastric Varices, with Report of a Case. Hugh F. Hare, Esther Silveus, and F. A. Ruoff. S. Clin. North America **28:** 729–732, June 1948.

Esophageal and gastric varices are demonstrated only by a combined study utilizing both fluoroscopy and films of the distal esophagus and fundus of the stomach. The patient should be examined upright and supine, with both thick and thin barium. Spot films taken in various projections may demonstrate small areas not visible fluoroscopically.

Esophageal varices must be differentiated from air bubbles, gastric mucosa in small hiatal hernias, tortuous folds (in older patients), mucus, curling and beading of the esophagus, and esophagitis. Varices in the fundus of the stomach are to be distinguished from carcinoma and localized gastritis.

The association of esophageal and gastric varices with cirrhosis of the liver has been reported, but little information is available as to the frequency with which they are diagnosed. In 16 cases of cirrhosis coming to autopsy, the authors found varices in 9. Twelve of these patients had been examined fluoroscopically but in only 2 were varices reported, and in one of these they were not present at autopsy. This would indicate that approximately 50 per cent of patients with cirrhosis of the liver have varices at the time of death, but that they can be shown by roentgenography in less than 15 per cent. It may be, however, that a more careful examination would have given a different figure.

Of particular importance is the demonstration of varices in the presence of hematemesis, as it may spare the patient an unnecessary operation. The case of a woman with a history of gastric hemorrhage and a roentgenologically demonstrable filling defect in the fundus of the stomach is reported. The picture was suggestive of tumor, and exploration was undertaken. The patient proved to have cirrhosis of the liver and splenomegaly. Varices along the greater and lesser curvatures were responsible for the filling defect.

Five roentgenograms.

G. REGNIER, M.D.
University of Arkansas

Thoracic Stomach Produced by Esophageal Hiatus Hernia and Congenital Short Esophagus. F. Johnson Putney. Ann. Int. Med. **28:** 1094–1105, June 1948.

This is a rather rambling article in which practically all types of diaphragmatic hernias of the stomach are touched upon. Nothing that is new is presented. Radiologists will not agree with the statement that esophagoscopy is needed along with fluoroscopy and films to make the diagnosis.

One case of congenitally short esophagus with thoracic stomach in an eight-year-old boy is illustrated. A case in a man of seventy-two with radiographic findings suggesting a congenitally short esophagus is also presented, but this was believed actually to be a hiatal hernia of long duration. In both these cases there was stenosis at the esophagogastric junction which caused difficulty in swallowing. Several other cases are briefly presented.

Five roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Diagnosis of Gastric Disease: Should Radiology of the Stomach Be Abandoned? V. J. Kinsella. M. J. Australia 1: 609–614, May 15, 1948.

The thesis of this author is the deplorable inaccuracy and inadequacy of radiological examination of the stomach as performed in Australia. He describes the usual routine as simply fluoroscopy and the taking of one or two roentgenograms with the patient erect. If his statements can be taken at face value, there is reason for his indictment.

The author believes that the clinician should be very thorough in his study of the patient's symptoms and signs. He should also be thoroughly familiar with radiologic procedures in the study of the stomach, including the appearance of the organ radiographically in all positions. He should look upon the radiologist as a valued assistant, but no more than an assistant, in the search for a diagnosis. He should instruct the radiologist in the manner in which additional studies are to be made when the preliminary radiologic diagnosis is not in accord with the clinical impression.

Cases from the author's own experience and that of others are cited in which the diagnosis by the radiologist was repeatedly in error. In some instances as many as six examinations were made over a period of years before a correct diagnosis was made. In almost every instance, the situation was hopeless by that time. Review of many of the earlier examinations indicated that the diagnosis should have been obvious on the first or second radiological examination in most instances. Examination should be done in the prone, supine, Trendelenburg and other positions, with rotation of the patient from side to side and the use of pressure filming to bring out details.

The author states that many of the inadequate and inaccurate examinations were done by senior, not junior, specialists in radiology. He believes that this can only imply need for much closer co-operation between radiologists and clinicians for the benefit of the patient.

[To those who desire the candid opinion of others of radiological efforts, this article is indeed worth reading in its entirety. Though it may not apply directly to American radiologists, its criticism of super-speed, inadequate, and inaccurate examinations is evidence that radiologists are not held in the highest esteem in some quarters. There is much of merit in articles of this type if they do nothing more than stimulate radiologists to carry out their examinations so thoroughly as to eliminate all possible sources of error and to correlate their findings with those of the clinician, the pathologist, and the surgeon for greater accuracy in the early diagnosis of gastric lesions.—B.S.K.]

Eighteen roentgenograms.

BERNARD S. KALAYJIAN, M.D.
Detroit, Mich.

Effect of Tetraethylammonium Chloride on Gastric Motility in Man. Donald C. Dodds, Carlton L. Ould, and Morris E. Dailey. Gastroenterology **10:** 1007–1009, June 1948.

Tetraethylammonium chloride is structurally similar to acetylcholine. The major action of this agent is to block transmission of both sympathetic and parasympathetic impulses at the autonomic ganglia. To determine the effects of the drug on gastric motility the authors studied fluoroscopically 20 apparently healthy men between the ages of twenty-one and fifty-five. The vigor of the peristaltic activity of the stomach was recorded and a plain film of the abdomen was made three hours after administration of barium. Subsequently the men were given 0.3 or 0.5 gm. of tetraethylammonium chloride, as a 10 per cent solution, and the study was repeated. The effects on gastric and intestinal movement and tone were noted and three-hour films were taken to demonstrate any gastric retention and any alterations in the passage of the barium through the bowel.

In all subjects peristalsis disappeared from the stomach and small bowel in an average of three minutes following injection, and the stomach appeared as a large atonic bag. Peristalsis remained absent on an average of forty-five minutes, but in some subjects it was not restored in one and a half hours. Movement returned sooner in the small bowel than in the stomach, and the three-four film showed no change from the control study in the speed with which barium traversed the bowel. There was a significant delay in gastric emptying, nearly half the group showing 25 to 70 per cent three-hour retention.

In the discussion, the authors point out that the appearance of the stomach after administration of tetraethylammonium chloride is strikingly similar to that after vagotomy. They feel that use of the drug as a safe non-surgical method of blocking the vagal effects on the stomach deserves thorough evaluation.

S. F. THOMAS, M.D.
Palo Alto, Calif.

Partial Gastrectomy. The Clinical, Gastroscopic, and Radiological Considerations. Moses Paulson and Eugene S. Gladsden. Gastroenterology **10:** 970–977, June 1948.

Clinical, gastroscopic, and radiologic studies were made in a series of 25 unselected cases in which subtotal gastric resection had been done. The patients covered a wide age range and the interval between operation and examination was from nine days to five years. The x-ray examination was reported as normal in all but 3 cases. One of the "early cases" (*i.e.*, examined prior to the twenty-first postoperative day) showed some retention of barium in the residual stomach at twenty-four hours, and another showed a slightly dilated distal jejunal loop. Of the cases examined later than the twenty-first day, only one showed any roentgenologic abnormality, namely a constriction about the stoma, resulting in delay in initial emptying but not after five hours.

The alterations observed through the gastroscope shortly after operation were usually localized about the stoma, consisting of edema with or without erythema. In contrast, the later changes tended to be more diffuse, with thickening, erythema, friability, and occasionally edema. The latter changes were variable, reversible even to normal, but recurrent.

In neither the earlier nor the later group was there any consistent relationship between the gastro-intestinal complaints and objective findings.

Three illustrations; 1 table.

Roentgen Diagnosis of Cancer of the Cardiac Region of the Stomach. Robert S. Sherman. Surgery **23:** 874–883, June 1948.

In a contribution to a symposium on cancer of the esophagus and cardia of the stomach, chiefly of surgical

interest, Sherman presents an excellent review of the anatomy of the cardiac region, the technic of its examination, the difficulties of diagnosis, and the things for which the radiologist should look. While he presents nothing new, he has left very little out. There are some who will disagree with accepting the healing of an ulcerative lesion as proof of its benignity, but that is a matter of judgment.

A series of 25 cases seen and operated upon at Memorial Hospital is analyzed to determine the accuracy of the roentgen findings. Close correlation with the gross pathology was found in practically all respects.

Unusual tumors in this area are also discussed, as well as the appearance following surgical removal and anastomosis.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Habitual Prepyloric Spasm. Martin L. Tracey. S. Clin. North America **28:** 777–783, June 1948.

A discussion of chronic, persistent, long-standing prepyloric spasm and its differentiation from organic lesions in the prepyloric area is presented. The diagnostic procedures consist of (1) repeated roentgenographic studies, (2) gastroscopy, and (3) therapeutic trials. After the spasm has been at least temporarily diagnosed, repeated x-ray examinations should be carried out in all possible positions, particularly with the patient supine and turned up toward the left side, the right side facing the fluoroscopic screen, thus giving an air-contrast effect. Gastroscopy has been disappointing because of the difficult angle from which the area to be examined must often be viewed. A positive gastroscopic study is helpful but negative findings do not exclude a lesion.

In the absence of an ulcer niche or any evidence of neoplasm, the author gives his patients a therapeutic trial consisting of bed rest and ulcer management in the hospital. If this is followed by complete freedom from distress, absence or disappearance of occult blood from all stools, and complete resolution of the defect, one can feel that the spasm was functional or benign.

Seven cases are discussed in which exploratory laparotomy was performed when other diagnostic efforts had not given an accurate diagnosis.

Two roentgenograms. JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Case of Benign Myoma in the Stomach. O. W. Husebye. Acta radiol. **29:** 525–528, June 30, 1948.

The author describes a case of myoma of the stomach, of unusual size and with irregular calcifications. The tumor filled the entire fundus and corpus of the stomach. Under fluoroscopy a duodenal sound was introduced and with a syringe small quantities of air were blown into the stomach. The air ascended between the tumor and the stomach wall, isolating the tumor, and outlining its smooth, regular surface and small pedicle. A subtotal gastrectomy was performed and the diagnosis was made histologically.

Four roentgenograms; 1 photograph.

ROBERT LARNER, M.D.
Baltimore (Md.) City Hospital

Prolapse of the Gastric Mucosa. Report of Six Cases. Ira A. Ferguson. Ann. Surg. **127:** 879–886, May 1948.

A review of the literature on the subject of prolapse of the gastric mucosa shows that relatively little has been written upon the subject. The condition is apparently secondary to a hypertrophic gastritis, the redundant mucosa finally being forced by peristalsis through the pylorus. Typical cases show a duodenal cap which is markedly concave at the base and rugal markings can be seen in the concavity.

Few cases have so far come to surgery, probably because the condition responds rather readily to medical treatment. Symptoms are those of a peptic ulcer, but not always typical.

The author presents 6 cases, in only one of which was operation done. A film of the operated case is reproduced, showing the typical findings.

Two illustrations. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Jejuno-Gastric Intussusception. A Rare Complication of the Operated Stomach. Sten Aleman. Acta radiol. **29:** 383-395, May 31, 1948.

The author has reviewed some 70 reported cases of jejunogastric intussusception following operation upon the stomach, of which 12 were diagnosed by x-ray. Clinically, the cases are divided into acute and chronic. The acute cases are characterized by extreme nausea and vomiting (first food, then bile, and finally blood) combined with intermittent colicky epigastric pain at the onset. The general condition is at first unaffected, as evidenced by a normal pulse and temperature; however, the pulse gradually rises. There may be some swelling and tenderness to the left of the epigastrium. When first seen, these patients are usually referred for roentgen study with a presumptive diagnosis of a paralytic ileus or a bleeding ulcer, and routine films which may be taken show nothing of significance. The author advises the use of a small amount of barium with compression for the examination of these cases and describes the following typical picture: The greater curvature of the stomach is convex cranially and the pyloric segment is displaced to the right. Neither is the gastro-enterostomy stoma seen nor is the evacuation of barium through it visualized. A striated filling defect in the form of an oval or sausage-shaped shadow protruding from the gastro-enterostomy stoma is pathognomonic. Across it are narrow streaks of contrast medium a few millimeters apart. With a small intussusception, these lie concentrically around a perpendicular axis. When enlarged, these streaks assume a band-like distribution. The streaks are due to a collection of barium between the Kerkring folds. The gastric mucosa is displaced cephalad and, when the patient is in the erect position, the barium sediment lies inferiorly in the stomach and the intussusception may float on the surface like a wire spiral.

The chronic case is less characteristic and the usual complaints center around a periodically recurrent discomfort. There is usually a sense of fullness in the epigastrium, with less vomiting than in the acute case and no hematemesis. Cramp-like epigastric pains may occur, but not necessarily. The discomfort is usually associated with meals and disappears an hour or so thereafter. There is no absolute obstruction in this group, and spontaneous reduction often occurs.

Three types of invagination occur: intussusception of the afferent loop (invaginatio descendens); intussusception of the efferent loop (invaginatio ascendens), accounting for 43 of 58 cases in which the type of invagination was indicated; a combined type with intussusception of both loops. From a roentgenologic point of

view, only those cases are of interest in which the apex of the intussusceptum lies within the stomach, making it theoretically possible to obtain the typical striated filling defect. These constitute about 85 per cent of the cases.

A case is reported in which a jejunogastric intussusception occurring some twenty years after a Billroth II stomach resection was diagnosed roentgenographically. The history would indicate that a similar intussusception six years earlier was spontaneously reduced.

Ten illustrations, including 8 roentgenograms.

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospital

A Case of Chronic, Non-Specific Jejunitis and Stenosis. O. W. Husebye. Acta radiol. **29:** 516–520, June 30, 1948.

The most difficult portion of the digestive tract to examine roentgenographically is the small intestine. The author reports a case of chronic inflammation of the jejunum in which the survey film revealed gas-filled intestinal loops with greatly thickened walls. The patient was then given a barium meal and the contours of the jejunum were noted. Its outline was irregular and there were defects in the contrast medium. Strictures were also demonstrable, and the barium was delayed in its passage. Cancer was suspected. At operation the stomach was found to be surrounded by adhesions and there were numerous areas of dilatation and stenosis in the jejunum, from the duodenojejunal junction to the ileum. The mucosa appeared to be chiefly affected, with the muscularis and serosa being secondarily involved. One portion of the bowel approximately one yard in length showed the serosa to be affected. Postmortem examination revealed about the same findings that were seen on operation. The histologic diagnosis was subacute chronic ulcerative inflammation.

Five illustrations, including 2 roentgenograms.

EUGENE R. KUTZ, M.D.
Baltimore (Md.) City Hospital

Diagnostic Case Study. [Gallstone Ileus.] E. W. Minty, O. L. McHaffie, and A. H. Wells. Minnesota Med. **31:** 656–659, June 1948.

This paper comes from a Clinico-Pathological Conference. The case reported is that of a woman of 63 years with a history of gallstone colic, followed many years later by a sudden attack of intestinal obstruction with fecal vomiting and typical roentgen findings. At necropsy a gallstone was found wedged in the ileum, the wall of which it had perforated. There was a healed cholecystoduodenal fistula.

Gallstone ileus is one of the late and serious complications of cholelithiasis, carrying a mortality of 40 to 50 per cent. It is invariably preceded by some type of cholecysto-enteric fistula but, while such fistulas are fairly common, gallstone ileus accounts for only about 2 per cent of all cases of small-bowel obstruction. Once the condition is suspected, it can be definitely diagnosed by roentgen examination. Finding of air in the bile ducts, as a result of the fistula, is the usual basis for diagnosis. Sometimes the bile ducts fill with barium, when the latter is given by mouth, but this can also occur with a large patent ampulla of Vater. At times an opaque stone is demonstrable in the small bowel, with proximal distention. During a barium enema the barium may flow into the terminal ileum and demonstrate the stone. Thorium chloride in dilute solution has been given by mouth and in three or four hours it may outline the calculus. Apparently this does no harm and is not contraindicated, as is barium by mouth, in cases of bowel obstruction.

As early diagnosis is imperative for the proper treatment of this condition, it should be considered a possibility in every elderly individual with a history of partial or complete bowel obstruction.

One roentgenogram; 1 photograph.

WILLIAM H. SMITH, M.D.
University of Louisville

Intestinal Intubation in Small Bowel Distention and Obstruction. Further Experiences with the Single Lumen Mercury Weighted Tube and Analysis of Complications. Franklin I. Harris and Milton Gordon. Surg., Gynec. & Obst. **86:** 647–658, June 1948.

As a result of their experience with the single lumen mercury weighted tube for intestinal intubation (see Harris: Surg., Gynec. & Obst. **81:** 671, 1945), the authors advocate certain changes in the structure of the tube and in the technic of its introduction. One restriction upon which they now insist is that progress of the tube downward be stopped at the 3-foot mark until an x-ray film has been taken. As previously emphasized, frequent flat films of the abdomen must be taken and the duration of intubation is determined by roentgenological as well as clinical improvement.

Twenty-four roentgenograms illustrate the use of the tube and some of the attending complications.

Enterogenous Cysts of the Duodenum. Report of a Case That Is Unusual If Not Unique. W. Lowndes Peple. Ann. Surg. **127:** 912–916, May 1948.

Enterogenous cysts of the duodenum are of rare occurrence. They are said to represent fetal inclusions. The author found 14 cases in the literature, the oldest patient being fifteen years of age. His own case is unusual in that symptoms developed at the age of sixty-nine, and roentgenograms made twenty-three years earlier showed a normal duodenum. The cyst was found just beyond the pylorus and had caused partial obstruction. The author is at a loss to know why, if the cyst was congenital, it was silent so many years and what the factor was that activated its growth.

Four illustrations, including 1 roentgenogram.

[For still another case of this unusual condition, see Lorber and Machella: Gastroenterology **10:** 892, 1948. Abst. in Radiology **52:** 605, 1949.—Ed.]

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Familial Polyposis and Carcinoma of the Colon. William L. Estes, Jr. Ann. Surg. **127:** 1035–1045, May 1948.

Polyposis of the colon occurs in the following main forms: (1) single or multiple polyps developing chiefly in adults as simple neoplasms of the mucosa with no known cause or following chronic inflammatory disease of the colon, as ulcerative colitis; (2) diffuse multiple polyposis, seen in childhood or early adulthood. The diffuse type usually has a marked hereditary and familial background with a strong tendency to malignant change at an early age.

The author presents the history of a woman and her seven children. Her father had died at forty years of age, cause unknown. She herself died of peritoneal carcinomatosis following resection of the sigmoid for a constricting adenocarcinoma. Multiple polyps were present in the colon. One of the children died in infancy. Of the remaining 6, all have either died of carcinoma of the sigmoid superimposed upon multiple polyposis or have been shown to have multiple polyposis of the colon or rectum with or without carcinoma.

Such a history as this makes clear the importance of thorough investigation of all members of a family in which diffuse polyposis of the colon has been found. The fact that three of this family who were completely symptom-free were found on examination to have well established polyposis indicates the fallacy of dependence upon history or symptoms alone for the diagnosis. This may be established by rectal examination, sigmoidoscopy, and double-contrast (barium-air) enema studies.

The treatment of choice seems to be colectomy with preservation of the rectum if it is not invaded by carcinoma. A low ileosigmoidostomy is done and, as polyps appear in the rectum, they are fulgurated.

Five illustrations, including 2 roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Mucosal Studies in Colitis Due to Parasites. Julian Arendt and Jack Coheen. Am. J. Roentgenol. **59:** 865–876, June 1948.

The authors stress the importance of the mucosal relief pattern as seen on the evacuation film as an aid in the diagnosis of parasitic infestations of the colon. They report such a study in 32 cases. In a high percentage of these, mucosal changes, such as spider-like widening and derangement of folds, were found in typical locations, particularly in the cecum, ascending colon, and sigmoid. In combination with the mucosal changes, increased spasticity was observed in these areas, sometimes with the characteristic cecal deformity described by Bell (Radiology **32:** 332, 1939). Not only severe but also milder types of *Endamoeba histolytica* infections (amebiasis proper) and one case each of *Diendamoeba fragilis* and *Monilia* infestation showed deviations from normal.

Changes in the cecal area and lower ascending colon combined (in a ratio of 2 to 1) with deviations from normal in the sigmoid are strongly suggestive of protozoan infestation, while continuous involvement of the colon ascending from the rectum and sigmoid suggests ulcerative colitis. The character of the ulcers is another distinguishing feature. The ulcers of amebiasis have been designated by the descriptive terms "button-hole ulcers," "sea-anemone ulcers," and "seaweed sloughs." Their demonstration in the cecum is barely possible with the contrast media at present available. In distinction from ulcerative colitis, the mucous membrane between the ulcers is preserved. The coexistence of ulcerative colitis and amebic colitis is diagnosed from the roentgen appearance of continuous involvement of the colon and demonstration of *Endamoeba histolytica* in the stools.

A number of excellent examples of the various mucosal patterns are reproduced. This article should be seen in the original by everyone doing barium studies.

Sixteen roentgenograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Ulcerating Carcinoma of the Sigmoid. Report of a Case with an Unusual Roentgen Picture. Maurice Feldman, Mark E. Gann, and Tobias Weinberg. Gastroenterology **10:** 1018–1021, June 1948.

This is an interesting case report of an ulcerating carcinoma of the sigmoid, which produced little narrowing or change in the contour of the lumen but was demonstrable in a barium enema study as a pseudopolypoid filling defect in the barium column. The case is otherwise not unusual but for the fact that the carcinoma was not of the common annular type but ran longitudinally with the long axis of the sigmoid colon.

Three roentgenograms; 1 photograph.

S. F. THOMAS, M.D.
Palo Alto, Calif.

Volvulus of the Sigmoid Colon. Victor D. Woronov, Bernard S. Epstein, and Henry W. Louria. New York State J. Med. **48:** 1364–1367, June 15, 1948.

The authors believe that two guiding factors might serve to reduce the high mortality in volvulus of the sigmoid (40 to 46 per cent), namely, early diagnosis and conservatism in treatment. They report 6 cases in detail, with fair illustrations. The method, which they followed was suggested in 1941 by Holmgren (Acta radiol. **22:** 404, 1941), who was successful in reducing a volvulus under fluoroscopic control with the use of a long enema tube.

The authors do not imply that this is permanent treatment of volvulus, since recurrences take place in about 20 per cent of the cases, but consider it useful for acute or subacute volvulus until the patient can be brought into complete control with proper preparation and adequate preoperative measures.

S. F. THOMAS, M.D.
Palo Alto, Calif.

Meckel's Diverticulum. Jerry W. McRoberts. Arch. Surg. **56:** 718–722, June 1948.

A general discussion with mention of 8 cases seen by the author in his practice. Three cases are reported in some detail. Special mention is given the complications of bleeding and obstruction due to a congenital band attached to the tip of the diverticulum. The other 5 cases were found accidentally at laparotomy.

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Temporary Failure of Gallbladder Visualization by Cholecystography in Acute Pancreatitis. H. L. Silvani and H. J. McCorkle. Ann. Surg. **127:** 1207–1211, June 1948.

In a group of 28 patients, cholecystograms were made during the acute phase of pancreatitis, with iodekon administered intravenously. The gallbladder was visualized normally in only 12 patients. In 6 of the remaining 16, cholecystography after subsidence of the acute phase of the pancreatitis gave normal visualization. Five others in the group were operated upon and found to have a normal gallbladder; in 5 no follow-up was obtained.

Apparently in some patients with pancreatitis the ability of the normal gallbladder to concentrate iodekon was lost temporarily during the acute phase of the illness. No evidence of impaired hepatic function was found in those cases in which liver function tests were done, and none of the patients was jaundiced. Ex-

planation of temporary failure of visualization is not apparent.

Six illustrations, including 3 roentgenograms, and 1 table.

DONALD R. BRYANT, M.D.
The Henry Ford Hospital

Intrathoracic Extension of Hepatic Tumors. Herbert D. Adams. S. Clin. North America **28:** 679–683, June 1948.

Two cases of hepatic tumor with extension into the thorax are recorded. In both cases the symptoms were primarily of thoracic origin. In the first case roentgenograms of the chest were reported as showing "clouding of the left base with an apparent soft-tissue mass just above the diaphragm which produces a depression on the air bubble of the fundus of the stomach indicating that the mass was fairly firm." The left diaphragm was elevated. The interpretation was "tumor of the left lung, probably malignant." Bronchoscopy revealed atelectasis of the left lower lobe from extrinsic pressure on the bronchus with no visible tumor. Exploratory thoracotomy revealed a dense, hard mass involving the left lower lobe, lingula, left diaphragm, and left lobe of the liver, which were resected. The pathologist diagnosed hepatoma arising from the left lobe of the liver.

One radiographic finding in this case is of significance in establishing the primary site of the lesion—the impression on the gastric air bubble by a soft-tissue mass. This is sometimes a finding in subdiaphragmatic abscess involving the left lobe of the liver, and in this case indicates that the primary tumor was beneath the diaphragm.

In the second case bronchoscopy was essentially negative. Roentgenograms showed a rounded mass of soft-tissue density in the anterior portion of the right chest, which appeared to be continuous with the diaphragm. The findings suggested either a hernia through the foramen of Morgagni or a pleural cyst. At operation there was found a localized eventration of the diaphragm with a rounded mass of normal liver protruding into the thoracic cavity, covered by a thin layer of atrophic diaphragm. This defect was repaired and the patient recovered. The symptoms were apparently due to a minimal bronchiectasis.

Three roentgenograms are reproduced but do not show all points mentioned in the text, due to losses in reproduction.

G. REGNIER, M.D.
University of Arkansas

Cholangiography. Magnus I. Smedal and C. Franklin Sornberger. S. Clin. North America **28:** 605–611, June 1948.

In the Lahey Clinic visualization of the biliary tract by means of opaque media is reserved primarily for those cases in which a plastic operation or a repair of a common duct has been performed or when the common duct has been opened and a T-tube left in it. In rare instances in which anomalies of the common duct have been encountered at operation, subsequent cholangiography may be of value to determine function. Diodrast is the medium employed and only occasionally is it injected under fluoroscopic control. The syringe method is used and at the slightest evidence of resistance the injection is discontinued and radiography begun.

The routine films are: a plain film before injection, an anteroposterior stereoscopic and a right lateral film of the right upper quadrant immediately after injection, a single anteroposterior and occasionally a right lateral film at fifteen to thirty minutes. The T-tube remains clamped until the last film has been taken.

Thirteen roentgenograms.

CHALMERS S. POOL, M.D.
University of Arkansas

Clinical Evaluation of Cholangiograms. Hart Hagan and H. L. Townsend. Ann. Surg. **127:** 810–815, May 1948.

Whenever a drainage tube is placed in the common duct or a bilary fistula exists, cholangiography can be done. If calculi are found, the cholangiogram should be made before the tube is removed and the patient dismissed. In an occasional case it will reveal a stone left behind during common duct exploration. By the use of a portable Bucky diaphragm, it is possible to obtain good films in the operating room at the time of surgery, the so-called "immediate" cholangiogram. This is undoubtedly the procedure of choice and, if adopted as a routine, should save many secondary operations. The technic is described.

The authors list the indications for cholangiography as follows:

(1) In common duct drainage and biliary fistula, delayed cholangiography is used in all cases to determine the presence of stones or other pathologic conditions, and to observe the return of the common duct to normal size and function.

(2) In acute cholecystitis, if cholecystectomy is performed, an "immediate" cholangiogram can be obtained by injecting the opaque medium through the cystic duct. If only a cholecystostomy is performed, there is no practicable advantage accomplished by an "immediate" cholangiogram; but a "delayed" cholangiogram, obtained by injecting an opaque medium through the drainage tube after free drainage has been established, will often give invaluable information.

(3) In cases of elective operations for chronic cholecystitis and cholelithiasis, the "immediate" cholangiogram can be used routinely without great difficulty or loss of time, by injecting the opaque medium through the cystic duct, the gallbladder, or the common duct.

(4) In anomalies of the ductal system encountered at operation, an "immediate" cholangiogram, obtained by injecting the opaque medium through the cystic duct or gallbladder, should be used and will give the surgeon assurance and comfort by furnishing immediate visual demonstration of the ductal system.

Mention is made of the difficulty of obviating respiratory movement during the rather long exposures necessary, but one wonders why the anesthetist could not hold the patient's nose and mouth closed for that time.

Seven roentgenograms; 1 drawing.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Hiatus Hernia, Diverticula and Gall Stones. Saint's Triad. C. J. B. Muller. South African M. J. **22:** 376–382, June 12, 1948.

The author was unable to find any reference in the literature to the association of hiatus hernia, diverticula of the colon, and gallstones. His attention was first called to this triad by Professor Saint of Cape Town (whence the designation Saint's triad) and he has him-

self seen 3 cases in a period of six months. He reports these cases briefly, discusses the signs and symptoms of the component diseases, and describes the technic of their roentgen demonstration.

In the differential diagnosis of hiatus hernia, three conditions must be kept in mind: phrenic ampulla, esophageal diverticulum, and other diaphragmatic hernias. Usually little difficulty is experienced in differentiating diverticula from other conditions, but they may on occasion simulate calcification in different sites from the region of the gallbladder to the left iliac fossa. Irregularity of the colon may suggest some resemblance to carcinoma. Gallstones must be distinguished from renal stones, calcified costal cartilages, etc.

Nine roentgenograms.

Papilloma of the Gallbladder: Case Report. Gordon McHardy and Edwin Edwards. New Orleans M. & S. J. **100:** 573, June 1948.

A case of papilloma of the gallbladder diagnosed roentgenologically and proved at operation is reported. The papilloma had separated from its pedicle and lay free in the lumen of the gallbladder.

One roentgenogram.

Certain Radiological Aspects of Acute Pancreatitis. J. Garcia-Calderon, R. Sarasin, and G. Marquis. J. de radiol. et d'électrol. **29:** 243–245, 1948. (In French.)

The authors describe the roentgenologic findings in the gastro-intestinal tract in two patients with acute pancreatitis. These consist principally of morphologic and functional changes in the stomach, duodenum, and jejunum. In the stomach, a laking in the horizontal portion of the pyloric antrum is described, extending on to the internal margin of the vertical segment. Dilatation with atonia of duodenum and jejunum, but also with compression by the pancreatic mass of the terminal portion of duodenum, is described in one case and, in the other, compression of the first loop of jejunum.

SIMEON T. CANTRIL, M.D.
Seattle, Wash.

THE MUSCULOSKELETAL SYSTEM

Myxedema with Delayed Closure of Epiphyses in Sexually Mature Women. J. C. Mussio Fournier, J. C. Barsantini, and H. C. Bazzano. J. Clin. Endocrinol. **8:** 482–486, June 1948.

The authors present the histories of 4 myxedematous women in whom there was evidence of a retarded closure of certain epiphyseal lines, though menstruation had begun a long time previously (eleven to twenty-nine years). These findings suggest that estrogens alone are not sufficient to lead to closure of the epiphyseal lines and that the thyroid hormone plays a part in the process. It may act directly upon the epiphyseal cartilages in co-ordination with the estrogens or, by direct or indirect action, it may induce the adrenal cortex to secrete some hormone which influences closure of the epiphyses.

In order to explain the greater delay in synostosis in panhypopituitarism than in ovarian insufficiency, Albright et al. (Am. J. M. Sc. **204:** 625, 1942. Abst. in Radiology **41:** 204, 1943) suggested that the adrenal cortex may contribute to closure of the epiphyses. The existence of an adrenal cortex deficiency in the course of myxedema is demonstrated by decreased 17-ketosteroid excretion, and by the return of this excretion to normal after the administration of desiccated thyroid. This is in accord with the hypothesis that a deficiency of the adrenal cortex may be a factor in myxedema contributing to delay in closure of the epiphyses in spite of normal ovarian function.

Two roentgenograms; 4 photographs.

Value of Routine Roentgenograms of the Wrist in a Pediatric Service. M. G. Peterman, W. B. Frey, and J. D. Kaster. Am. J. Dis. Child. **75:** 671–687, May 1948.

As an argument for adoption of routine filming of the wrists of all children requiring medical attention, the authors analyze their observations in 684 cases, half of which represented hospital admissions and half private patients. The percentage of abnormal findings was practically the same in each group, 10.21 per cent for the hospital series and 9.97 per cent for the private cases. Slightly more than half the children showed only delayed ossification. Other entities seen included rickets, scurvy, congenital syphilis, lead poisoning, mongolism, chondrodystrophy, osteochondroma, osteitis, and pubertas praecox.

[Routine examination of any part of the body is always productive of a certain amount of unsuspected pathology but the practice has two very definite disadvantages. First of all it would add considerably to the medical bill of the nation if every pediatric case were to be filmed and secondly any routine procedure tends to dull the clinician's acumen and to make him more and more dependent upon others for his diagnoses. We suspect that things of this nature would be done in all fields under a socialized system.—Z.F.E.]

Five roentgenograms; 6 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Dysostosis of Skull, Face and Extremities (Acrocephalosyndactyly). Robert W. Buckley and Paul I. Yakovlev. Am. J. Dis. Child. **75:** 688–694, May 1948.

The literature on acrocephalosyndactyly is reviewed and a single case is reported. The interesting findings on roentgenography were: (1) acrocephaly (short anteroposterior diameter, increased distance between base and vault, with deep digital markings in the frontal bone); (2) fusion of both shoulder joints; (3) short, bowed humeri; (4) shortening, deformity, and partial fusion of phalanges.

The condition is believed to be due to a germ-plasm defect influencing the growth of both "cartilaginous" and "membranous" bone. In only 1 case in the literature was a familial tendency evident.

Three roentgenograms; 5 photographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Infantile Cortical Hyperostoses. Report of a Case. Katherine T. Chen and Ting-Sing Yu. Chinese M. J. **66:** 266–267, May 1948.

A case of infantile cortical hyperostoses is reported from China. The findings differed from the typical picture described by Caffey (see Caffey and Silverman: Am. J. Roentgenol. **54:** 1, 1945. Abst. in Radiology **46:** 538, 1946) in several respects: The lesions were at first limited to the long bones of the extremities, with no mandibular involvement demonstrable clinically or

roentgenographically until the age of six months; the radii were predominantly involved and the ulnae only slightly so; fever was absent throughout most of the course.

Multiple Cartilaginous Exostoses (Hereditary Deforming Chondrodysplasia). Fun-Yong Khoo, Ping-Yi Chang, Ching-Tan Lee, and Kuo-Sheng Fan. Chinese M. J. **66:** 252–256, May 1948.

Multiple cartilaginous exostoses appear to be as common among the Chinese as among other peoples. Seven cases seen in a period of four years are here recorded, with the roentgen findings. Four of the patients were members of the same family and in two others there was evidence of a definite hereditary factor.

Five roentgenograms.

Ollier's Disease. Report of Case. Roger W. Dickson and Shirley M. Cohen. J. M. A. Georgia **37:** 205–207, June 1948.

A boy of 22 months showed the characteristic features of Ollier's disease (hereditary deforming chondrodysplasia). Bony projections were palpable along the anterior axillary regions of the ribs and at the upper ends of all the long bones, most marked at the distal ulnae, proximal humeri, distal femora, and proximal tibiae. The long bones were slightly diminished in length. Exostoses were also present in the child's father and two paternal uncles. On roentgen examination both showed some deformity of the long bones with cyst-like areas of cartilaginous exostoses.

The transmission of the disease was through the paternal grandmother. She herself had no apparent lesions, but two of her sisters had a few small bony projections, and one brother had many large ones.

Two roentgenograms; 1 chart.

Ewing's Sarcoma of the Rib. Edward M. Kent and F. S. Ashburn. Am. J. Surg. **75:** 845–848, June 1948.

A brief review of the literature of the past ten years reveals 311 cases of Ewing's sarcoma, 21 of which were considered to be primary in the ribs. The authors furnish a digest of the natural history of the process, its diagnosis, and proposed forms of therapy. Their case was that of a 17-year-old boy who complained of left chest pain for one year and chest deformity of five months duration. After diagnosis by aspiration biopsy, roentgen therapy was given to the extent of 5,000 r, at 400 kv. The large mass decreased rapidly and its remainder was later excised. The tumor arose from the fifth rib and had extended to involve the left lung, about one-third of which was also resected. The patient was well thirteen months after operation, but the authors believed his prognosis to be poor.

Five roentgenograms. HORACE G. BUTLER, M.D.
University of Pennsylvania

Osteoid Osteoma. J. E. Pritchard and J. W. McKay. Canad. M. A. J. **58:** 567–575, June 1948.

The osteoid osteoma is a small but usually painful, tender, and troublesome benign lesion of bone. It has often been mistaken for other conditions such as chronic osteomyelitis, cortical abscess, sclerosing osteitis, osteochondritis dissecans, tuberculosis, bone cyst, and even sarcoma. The differential diagnosis is not always easy without the aid of histologic sections.

Fifteen cases of osteoid osteoma are presented in this report with x-ray and histologic findings. Early in the course of the disease, even though pain and tenderness and sometimes swelling of the soft tissues are marked, there may be no noticeable radiologic change. At a demonstrable stage, a more or less rounded nodule, commonly 0.5 to 1.0 cm. in diameter, is seen. It may be entirely within cancellous bone, entirely within the cortex, subperiosteal, or in the deep margin of the cortex bulging into the medulla. The consistency of the nodule varies from that of soft, spongy to hard bone. It may be brownish red, pink, or pearly gray.

The fundamental nature of the osteoid osteoma is that of a very cellular osteoblastic type of connective tissue, well vascularized and containing numbers of multinucleated giant cells. It reminds one of the type of tissue seen in the metaphysis of growing bone. Small, irregular, scattered deposits of osteoid can be detected. At this stage the roentgenogram will reveal a small, more or less rounded radiotranslucent area which is comprised of the non-calcified tumor and the immediately surrounding zone of reactive connective tissue. At the periphery, new bone formation may be stimulated, producing a rim of condensation about the rarefied nodule.

The next phase is calcification of the osteoid. Beyond the margin of the tumor nodule the vascular connective-tissue zone persists. The roentgen appearance will now be that of a central opaque body surrounded by a zone of radiotranslucency.

Osteoid osteoma is a disease affecting chiefly young adults and adolescents and occurs about twice as often in the male as in the female. The predominant location is in the bones of the lower extremities. As yet this tumor has not been reported in the ribs, clavicles, scapulae, or skull bones other than the mandible. Pain is the outstanding symptom and swelling of the regional soft tissues is often found. Trauma cannot be considered an etiologic factor. There is usually no significant rise in temperature, pulse rate, or leukocytes, and regional lymph nodes rarely enlarge. Surgical removal usually gives prompt relief of symptoms and a lasting cure.

Seventeen illustrations, including 8 roentgenograms.
WYNTON H. CARROLL, M.D.
The Henry Ford Hospital

Eosinophilic Granuloma of Temporal Bone Associated with Diabetes Insipidus. A Case Report. J. Lewis Dill. Ann. Otol., Rhin. & Laryng. **57:** 531–537, June 1948.

Eosinophilic granuloma has been observed in practically all the bones of the body except the carpals, metacarpals and phalanges and the corresponding bones of the feet. The most common symptom is mild local pain, associated with swelling of the soft tissues and tenderness. In a limited number of cases an increase in the eosinophils in the blood has been found. Two cases have been reported in association with diabetes insipidus, and a third is here recorded.

In this case, the diagnosis of diabetes insipidus was made at the age of two and a half years. At four and a half years the child was seen with a fourteen-months history of a draining right ear. Examination of the ear showed a purulent discharge in the canal and a swelling of the posterior canal wall, resembling a furuncle; the ear drum was not visualized. A roentgenogram revealed clouding of the right mastoid with some destruction. A mastoidectomy was advised but was

refused by the parents. On March 5, 1946, the tonsils and adenoids were removed. At that time the right ear was still draining and the furuncle of the posterior auditory canal wall was still present. On Dec. 30, 1946, roentgenograms showed sclerosis throughout the extent of the right mastoid. No cells were visualized. A large irregular area of destruction of the temporal bone above the mastoid was found.

A right simple mastoidectomy was performed in January 1947. A large, oval, irregular area of the temporal bone was found destroyed and the dura exposed. The mastoid cells had been competely replaced by a whitish cholesteatomatous material, which protruded through the fistula of the posterior canal wall. A pathologic diagnosis of eosinophilic granuloma was made.

Shortly after operation, small secondary lesions were observed in the right parietal bone, demonstrable as rounded shadows of decalcification. Following x-ray therapy these areas appeared to have recalcified. The dose was 400 r to each of two fields, a right mastoid and a right parietal, administered in 100 r fractions at intervals of three or four days. The factors were: 140 kv., 6 ma., 0.5 mm. Cu and 1.0 mm. Al filtration, half-value layer 0.5 mm. Cu, 24 cm. distance, 39 r per minute.

Four roentgenograms. STEPHEN N. TAGER, M.D.
Urbana, Ill.

Eosinophilic Granuloma of Rib. Elmer Maurer and George A. DeStefano. J. Thoracic Surg. **17:** 350–356, June 1948.

Thirty-nine cases of eosinophilic granuloma of bone have been reported and only 6 of these have been solitary in a rib. A case is reported in a 16-year-old boy in whom the left fifth rib posteriorly showed an expanding lesion of a destructive nature 9 cm. long. The only complaint was pain over the anterior left chest for one month. There were no abnormal physical findings. The most probable preoperative diagnosis was osteogenic sarcoma, and the lesion was widely resected. It proved to be an eosinophilic granuloma.

Solitary eosinophilic granuloma of bone may simulate bone cyst, giant-cell tumor, Ewing's tumor, solitary myeloma, osteogenic sarcoma, or osteomyelitis. Multiple lesions may resemble multiple myeloma, metastatic tumor, osteitis fibrosa cystica, Letterer-Siwe disease, or Hand-Schüller-Christian disease. Actually these last two diseases are probably the same as eosinophilic granuloma with different clinico-anatomic expressions.

The authors advocate surgical excision, although some lesions heal spontaneously and others have responded to roentgen therapy.

One roentgenogram; 2 drawings; 2 photomicrographs. HAROLD O. PETERSON, M.D.
University of Minnesota

Solitary Bone Cyst of the Os Calcis (A Form of Osteitis Fibrosa). John M. Hundley. J. Arkansas M. Soc. **45:** 7–8, June 1948.

The solitary bone cyst, a form of osteitis fibrosa cystica, is usually found in the proximal portion of the femur, the humerus, and the tibia. Cases involving the frontal bone, mandible, patella, etc., have been reported. The author presents a case because of its unusual location—the os calcis. Only 4 previous cases of solitary bone cyst in this site have been recorded.

Multiple Cystic Tuberculosis of the Bones. McLemore Birdsong and Camillus S. L'Engle, Jr. Pediatrics **1:** 767–770, June 1948.

Proved cases of multiple cystic tuberculosis of the bone are uncommon in the pediatric literature, only 13 cases having been previously recorded. The case of a thirteen-month-old child is presented with the rare combination of cystic tuberculosis in the flat and long bones as well as in the bones of the hands and feet.

Three roentgenograms.

Multiple Myeloma with Spinal Cord Compression as the Initial Finding. Leopold J. Snyder and Seymour K. Wilhelm. Ann. Int. Med. **28:** 1169–1177, June 1948.

A single case of multiple myeloma causing paraplegia by extension into the spinal canal is presented in detail. Initial films made before the paraplegia became complete showed a paravertebral soft-tissue mass and destruction of one pedicle of the fourth dorsal vertebra, the body of which was partly collapsed. An air myelogram showed an incomplete block, with displacement of the cord at that level. Retrograde pyelography ruled out a primary tumor in the genito-urinary tract. Laminectomy was done and as much of the mass as possible was removed. It had not become attached to the dura. After a microscopic diagnosis of plasma-cell myeloma was made, the skull was x-rayed and typical "punched out" areas were demonstrated. The decompression of the cord, followed by deep roentgen therapy, resulted in almost complete recovery from the paralysis. The ultimate prognosis is, of course, hopeless but the patient was able to return to work.

This case serves to emphasize two points worth remembering: (1) Do skull films when a neoplasm of unknown origin is seen in the spine. (2) Laminectomy for decompression is worth the effort if there is pressure on the spinal cord.

Four roentgenograms; 2 photomicrographs; 1 chart.
ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Gout: Report of an Unusual Case in a Young Man. Morton E. Berk. Am. J. M. Sc. **215:** 290–295, March 1948.

A man aged 28 complained of pain in the interphalangeal joints, especially in the left small finger. At the age of eleven he had experienced recurrent bouts of pain in the metatarsophalangeal joints of both great toes. At the age of twenty-two, because of pain in the right great toe, an operation was performed and the contents at the base of the second phalanx were removed. They proved to be sodium urate crystals, but the patient was not informed of the diagnosis. He had had two hospital admissions during the past year and had been discharged with a diagnosis of rheumatoid arthritis.

Most of the joints in the extremities were swollen, tender, and deformed, and their movements were restricted. Purulent material was trickling from the distal interphalangeal joint of the right fifth finger, which was very tender. Sodium urate crystals were found in a small "cyst" behind one ear. Roentgenograms showed extensive destruction of the first metatarsal and the proximal phalanx of the great toe. Amputations of the great toe and infected finger were performed, along with removal of the tophaceous material.

Although the onset of this disease is rarely before thirty-five, this patient had distinctly gouty symptoms which had appeared before the age of eleven. A very poor individual, he had subsisted on a basic diet, rarely supplemented by alcoholic beverages. Tophi commonly are found at the ear margins; his resembled a sebaceous cyst behind the ear. On five occasions this patient had blood uric acid studies under the normal upper limit. It has not been sufficiently stressed that acute arthritis or gout is of an inflammatory nature, with a high sedimentation rate. The temperature was above normal during all periods of pain.

Careful removal of the tophaceous material brings relief from crippling pain.

Two roentgenograms; 2 tables.

BENJAMIN COPLEMAN, M.D.
Perth Amboy, N. J.

Osteoarthritis of the Cervicodorsal Spine (Radiculitis) Simulating Coronary-Artery Disease. Clinical and Roentgenologic Findings. David Davis and Max Ritvo. New England J. Med. **238:** 857–866, June 17, 1948.

This is a study of 43 patients with radiculitis, in 23 of whom coronary artery disease was suspected from the presenting symptoms. There have been several presentations of roentgen findings in cervical radiculitis, but there are few data on the changes in dorsal radiculitis.

The diagnosis of radiculitis is based on the presence of at least two of the following criteria: symptoms with definite radicular characteristics; reproduction of attacks by pressure over the spine; and prompt response to orthopedic therapy. The pain is rather characteristic, with attacks coming on in bed at night, precipitated or aggravated by change in position; it may be produced, also, or accentuated by coughing or straining at stool.

In the group of 43 patients studied, 32 were males and 11 were females. They were observed over a period of weeks or months before a definite diagnosis of radiculitis was established. The outstanding clinical findings were attacks of severe substernal or precordial pain radiating to the left upper extremity or neck or jaw. The pain is described as a pressure sensation, heaviness, or a vise-like constriction. It closely resembled the pain of coronary heart disease. Some patients complained of a peculiar respiratory distress, in the nature of inability to take a deep breath.

Any factor that narrows the intervertebral foramen may cause nerve root irritation. Marginal osteophytes, thinning of the intervertebral disks, osteoarthritis of the posterior articulations, and postural changes may affect the size of the foramina. The roentgenologic demonstration of osteoarthritis may be a great aid in establishing a diagnosis of radiculitis particularly where the symptoms are of short duration and the attacks cannot be reproduced or the pain is not of the characteristic type.

Five roentgenograms; 2 tables.

JOHN B. MCANENY, M.D.
Johnstown, Penna.

Value of Conservative Management in Cervicobrachial Pain. G. E. Haggart. J. A. M. A. **137:** 508–513, June 5, 1948.

The author reviews the various causes of cervicobrachial pain and stresses the favorable results obtained by conservative therapy. He divides the cases into two groups (1) those with abnormalities apparent in a roentgenogram (cervical rib, abnormal first rib, cervicodorsal scoliosis, asymmetry and variations in thoracic outlet, arthritis, and protrusion of cervical disk shown by myelogram) and (2) those with abnormalities not apparent in the roentgenogram (scalenus anticus syndrome, costoclavicular compression, hyperabduction syndrome, causalgia or sympathetic dystrophy, and postural defects, *i.e.*, abnormal relationship of shoulder to thoracic cage).

Those difficulties included under postural defects are believed to be the most frequent. The author feels that "sagging and drooping of the shoulders exert tension on the brachial nerve roots and blood vessels, stretching the structures still more tightly over the upper edge of the thoracic outlet." Likewise, during growth, as the gradual descent of the thoracic structures progresses, the frequency of difficulty increases, especially in women.

The clavicle and an abnormal rib may constitute a vise, in which the third part of the artery as well as the plexus are gripped.

Hypertrophic changes can develop to the point where there is spur formation large enough to protrude into the intervertebral foramina.

Pain due to herniated disks is quite rare.

In cervical ribs over 5 cm. long, one can expect trouble, especially if this rib is fused with the first rib.

Many cases of scalenus anticus syndrome are relieved because of the removal of one jaw of a vise. The author found no histological evidence of hyperplastic or fibrotic muscle.

In the hyperabduction syndrome, the scalenes are relaxed whereas the pectoralis minor compresses the vessels and nerves.

Haggart's 20 patients ranged in age from twenty-four to sixty years (average thirty-nine). Females predominated, 3:1. Fifty per cent were employed in occupations where constant use of the arms or prolonged flexion of neck and shoulders was required. Thirty-five per cent were housewives. In 15 per cent there was no relation to occupation. There were 3 cases of cervical ribs, 3 of protruded cervical disks, 3 of degenerative spondylitis, 1 of scoliosis, 3 of anterior scalene syndrome, 3 of costoclavicular compression syndrome, 3 of hyperabduction syndrome, and 1 case of trauma.

Most of the patients were treated on an ambulatory basis, with graduated exercises, postural training, sleeping posture training, and change in type of employment. Except for causalgia, where sympathectomy is the treatment of choice, all cases were given a trial of conservative therapy before surgery was recommended.

Seventeen of the 20 patients had good and excellent results on conservative therapy. One disk case, 1 hypertrophic spondylitis case, and 1 costoclavicular compression case had only "fair" results.

S. B. FEINBERG, M.D.
University of Michigan

Causation and Treatment of Painful Stiff Shoulder: Subdeltoid Bursitis, Periarthritis, Tendinitis, and Adhesive Capsulitis. Henry W. Meyerding and John C. Ivins. Arch. Surg. **56:** 693–705, June 1948.

The causes of stiff, painful shoulder are many. Inflammatory degeneration in the rotator cuff, with

calcification which may rupture into the subdeltoid bursa, is only one of these. Tuberculosis of the shoulder joint, tuberculous bursitis, acromioclavicular separation, fracture of either the glenoid or the greater tubercle of the humerus, ruptured supraspinatus tendon, infection of the joint, osteomyelitis, tumor, and occasionally even coronary disease may be accompanied by a stiff, painful shoulder. The 150 cases on which the present report is based represent almost entirely chronic degenerative conditions of the rotator cuff, and most of them had received more or less treatment elsewhere.

In the acute stages, rest in bed, local heat, increased fluid intake, traction, and anodynes are used. Abduction is encouraged, and diathermy and roentgen irradiation may be used. In the subacute recurring stage, conventional diathermy, radiant heat, stretching, and active and assistive exercises should be carried out routinely. If abduction remains difficult, traction or manipulation followed by an abduction splint is used. Physical therapy was employed in all patients, but when conservative measures failed, surgical treatment was used. Curettage or excision of the calcified area is employed, with needling and manipulation to break up adhesions after operation. Local injection of procaine or block of the suprascapular nerve may give added benefit. A routine postoperative or postmanipulative film should be made to exclude fracture.

Forty of the reported cases had roentgen therapy, repeated small doses being centered over the point of maximum tenderness. In the acute stage, a dose of 75 r was given on alternate days for three or four doses, while in the subacute or chronic stage 100 r was given twice weekly. Results were more favorable in the acute stage. Considering all patients and all forms of treatment, a favorable result was obtained in 85 per cent of the patients.

Three roentgenograms; 2 drawings; 1 photograph.

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Avulsion Fracture of Lesser Tuberosity of Humerus. Report of a Case. A. T. Andreasen. Lancet **1:** 750–751, May 15, 1948.

A case of avulsion fracture of the lesser tuberosity of the humerus is reported. This is apparently a rare injury. In the present instance it was caused by an effort, with the arm fully abducted above the shoulder, the hand being fixed and the body moving, to save a fall on dismounting from a horse. The circumflex nerve was contused and hemarthrosis developed. Operation was refused by the patient. Recovery was complete except for internal rotation at the scapulohumeral joint. The detached fragment of bone first underwent aseptic necrosis and then was absorbed in fourteen months. Roentgenograms are reproduced.

Anterior Dislocation of the Elbow with Fracture of the Olecranon. Lawrence H. Strug. Am. J. Surg. **75:** 700–703, May 1948.

While anterior dislocation of the elbow is probably not extremely uncommon, only 35 cases have been reported. In 8 of these there was an associated fracture of the olecranon. Most of the reported cases have occurred as a result of a direct blow upon the elbow. A fall on the flexed elbow, as in the author's case, is also a common occurrence. The type associated with fracture results in severe soft-tissue damage and injury to the vessels. In a few instances, rupture of the brachial artery has occurred. A considerable amount of swelling, hematoma formation, and possible extensive laceration of the triceps tendon result. Operative intervention may occasionally be necessary.

The author's patient was an 11-year-old boy who fell off a bicycle, landing on his flexed elbow. The roentgenograms showed anterior overriding of the ulna and radius on the distal end of the humerus. The epiphysis and proximal fragment of the olecranon remained posteriorly. Treatment was instituted early and a successful anatomic result was obtained by closed reduction. The course was uncomplicated.

Five roentgenograms; 1 table.

DAVID S. MALEN, M.D.
University of Pennsylvania

Contralateral Fracture of First and Second Ribs Following Thoracoplasty. Albert Guggenheim and Bernard N. E. Cohn. J. Thoracic Surg. **17:** 366–373, June 1948.

An analysis of 208 consecutive cases of thoracoplasty revealed fractures of the first rib on the contralateral side in 6 cases and of the first and second ribs in 2 cases. Four of these patients were males and 4 females. All were between the ages of twenty-six and forty. All but one of the fractures were in the middle third of the rib. This is the thinnest part of the first rib, as it corresponds to the site of the subclavian grooves. In this area, also, muscular stress would probably be the greatest.

The authors believe that these fractures are due to prolonged muscular traction. They assume that removal of ribs during the first stage of a thoracoplasty alters the normal mechanics of the muscles attached to the first and second ribs on the contralateral side. Consequently the pull of these muscles is unopposed. Except in one case the fractures were painless.

Thirteen roentgenograms; 1 drawing.

HAROLD O. PETERSON, M.D.
University of Minnesota

Fractures of the Acetabulum: The Nature of the Traumatic Lesions, Treatment, and Two-Year End-Results. Marshall R. Urist. Ann. Surg. **127:** 1150–1164, June 1948.

This is the second in a series of three papers concerned with the analysis of 58 injuries of the hip joint occurring in jeep accidents in World War II. (For the first, see Am. J. Surg. **74:** 586, 1947. Abst. in Radiology **51:** 442, 1948.) The present contribution deals with 16 cases of fracture of the acetabulum without dislocation. These are divided into three groups: 5 cases of fracture of the rim of the acetabulum, 8 cases of central fracture, 3 cases of comminuted or bursting fractures disorganizing the entire joint cavity. These 16 cases incurred in military service are compared with 7 similar cases studied on the Fracture Service of the Massachusetts General Hospital.

Fractures of the superior and posterior rims of the acetabulum of significant magnitude almost always resulted in some disability, but good function in the joint was obtained in one case after open reduction and accurate internal fixation.

Central fractures of the acetabulum can be classified in two groups: (A) Fractures limited to the pubic portion of the acetabulum and the descending ramus

of the pubis, even with intrapelvic protrusion of the head, responded well to conservative treatment and showed an excellent functional result after one to three years. (B) Fractures bursting the triradiate line of the acetabulum were impossible to reduce by conservative methods and resulted in great disability. Fusion or orthoplasty was advised in three such cases after two years.

All the evidence is to the effect that fractures of the pubic portion of the acetabulum are chiefly lesions of the anterior rim, which is not essential to the function of the hip joint, while stellate or bursting fractures involve or distort the lunate superior and posterior articular cartilage of the acetabulum, which is essential for normal weight-bearing.

Six roentgenograms; 2 tables.

DONALD R. BRYANT, M.D.
The Henry Ford Hospital

Skeletal Lesions in Leukemia. Clinical and Roentgenographic Observations in 103 Infants and Children, with a Review of the Literature. Frederic N. Silverman. Am. J. Roentgenol. **59:** 819–843, June 1948.

The literature on the subject of bone lesions in leukemia is exhaustively reviewed, followed by an analysis of a series of cases seen in the Babies Hospital, New York, from 1924 to 1947. The total number of cases was 131, for 103 of which satisfactory roentgenograms were available [a remarkably high percentage, since only one-half had bone pain]. The children ranged in age from twenty-two days to twelve and a half years.

Four types of bone lesions were seen: transverse bands of diminished density, osteolytic areas, osteosclerosis, and subperiosteal new bone formation. Some patients showed more than one type of lesion. Fifty-two of the 103 showed bone changes, but it is pointed out that in others bone involvement may have developed after the initial films were made, since it was in the late stages that lesions were more often found and many patients had left the hospital before their disease became advanced.

Two case histories of leukemia and 3 which simulated leukemia are presented in detail.

This paper is well worth reading in the original.

Fifteen roentgenograms; 6 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

GYNECOLOGY AND OBSTETRICS

Hysterosalpingography Employing a Water-Soluble Contrast Medium. Derek Jefferiss. J. Obst. & Gynec. Brit. Emp. **55:** 270–272, June 1948.

The author has used "Pyelosil," which is a 35 per cent solution of the diethanolamine salt of 3:5-di-iodo-4-pyridone-N-acetic acid, for testing the patency of the fallopian tubes. Its advantage lies in its rapid absorption (one hour) and therefore probable absence of irritating effects. Its use in 24 cases is reported. In 19 of these the tubes were found to be patent. Operation was done in 3 of the 5 patients in whom obstruction was found. In 2 this was due to pyosalpinx and in 1 to a tuberculous salpingitis. No therapeutic value is claimed for the method. In fact, the author believes it questionable whether any form of uterotubal insufflation is likely to be of therapeutic benefit except in very recent cases of anatomical obstruction. He points out in this connection that an impressive number of women on a long waiting list for insufflation for sterility became pregnant before they could be admitted for the procedure. Had it been carried out, they might have been considered examples of its success.

Four roentgenograms. S. F. THOMAS, M.D.
Palo Alto, Calif.

Characteristics in Hysterosalpingograms in Tuberculous Salpingitis and Endometritis. Ko-Chi Sun. Am. J. Obst. & Gynec. **55:** 953–960, June 1948.

Observations were made of 6 patients in a series of 138 sterility problems at the Shanghai (China) Woman's Hospital. All were examined with plain films and hysterosalpingograms by the fractional method of Joachimovitz and Hyams on the eleventh day of the menstrual cycle; a twenty-four-hour film completed the study. The diagnosis of tuberculous salpingitis and endometritis was confirmed by operative specimens.

The abnormal findings are briefly described. On the plain film, x-ray opaque bodies were seen in the pelvis. Filling of the uterus and tubes was slow. When filled, the cervical canal appeared fuzzy or "feathered," and the uterus convex with bulging contours. Filling of the tubes, when it occurred, did so in a jerky, fragmented fashion, and they appeared stiff or wiry, similar to filaments. Finally, the contrast medium was unevenly distributed, with lack of spread to the free peritoneal cavity.

The author gives an analysis of the pathology involved, reviews previously reported cases, and outlines the differential diagnosis.

Ten roentgenograms.

FREDERICK R. GILMORE, M.D.
Jefferson Hospital, Philadelphia

On Hysterosalpingography and Extra-Uterine Pregnancy. Henning Skjoldborg. Acta radiol. **29:** 456–460, May 31, 1948.

Hysterosalpingography is of help in diagnosing tubal pregnancy in cases where there is a slowly proceeding tubal abortion with periodic hemorrhages and hematocele formation.

The typical hysterosalpingogram in tubal pregnancy will appear as follows:

The affected tube will be slightly swollen laterally. It will appear trumpet-shaped and passage of the medium will be obstructed laterally. There is usually a net-like appearance which is separated from the rest of the contrast medium. This is apparently due to a small amount of the contrast medium having made its way in a very thin layer between the ovum and the tube wall.

A method devised by Kjellberg for hysterosalpingography is described. (Suppl. XLIII, Acta radiol., 1942. Reviewed in Radiology **46**: 416, 1946). In this method a Günther-Schultze apparatus is inserted. Twenty five per cent perabrodil with 1 per cent procaine is injected into the uterus under slight pressure, approximately 20 to 40 c.c. of the contrast fluid being used. Perabrodil is water-soluble, which makes it especially satisfactory, since a water-soluble medium distributes itself more evenly and more rapidly through small cavities.

Three proved cases of extra-uterine pregnancy are described with the hysterographic findings.

Four roentgenograms. EUGENE KUTZ, M.D.
Baltimore (Md.) City Hospital

Clinical Interpretation of X-Ray Pelvimetry. Howard P. Taylor. Ohio State M. J. **44:** 608–611, June 1948.

In the author's opinion, clinical measurement of the pelvic outlet is more accurate than x-ray study, and routine roentgen pelvimetry is neither necessary nor desirable. It is indicated (1) in all primiparas in whom the head is unengaged two weeks prior to term, (2) in all breech presentations, (3) in all compound presentations, (4) in all multiparas with a history of previous difficult labor, and (5) during labor if arrest occurs in a multipara.

At least ten methods of pelvimetry are in use, and it is suggested that the type of procedure is of less importance than experience in its application. Qualitative methods are exemplified by precision stereoscopic filming, in which the pelvic measurements are reduced to linear measurements identical with those in clinical use. The quantitative methods, of which Ball's is an example, express cubic capacity of the pelvis in relation to cubic capacity of the fetal head, and have little meaning for the average clinician.

Two methods of morphologic classification are in use: that of Caldwell, Moloy, and Swenson (gynecoid, platypelloid, anthropoid, android, and asymmetrical, with further division into mixed types) and that of Thoms, based on the ratio between the anteroposterior and transverse diameters of the inlet (dolichopellic, mesatipellic, brachypellic, and platypellic). The roentgenologist and obstetrician must both be familiar with the classification employed and its implications.

The x-ray report should include a general description of the development and approximate size of the fetus, its presentation, position, attitude, and the degree of descent of the head; cephalic measurements, including occipito-frontal, biparietal, and suboccipito-bregmatic; any observable soft-tissue shadows; morphologic classification of the maternal pelvis and actual measurements of the pelvic diameters. The roentgenologic conclusions should be stated as no evidence of disproportion, evidence of moderate disproportion, or severe disproportion. Clinical interpretation of these findings is the obstetrician's responsibility.

Errors in roentgen predictions are due to the obvious inability to estimate the amount of pelvic space occupied by soft tissue, uncertainty as to the behavior of the cervix during labor and the degree of molding of the fetal head, lack of knowledge of the age of the patient and her previous obstetrical history, and of the skill of the attending obstetrician.

Proper evaluation of each case can be obtained only by close co-operation between roentgenologist and obstetrician. The former should be familiar with roentgen technic which renders reasonably reliable measurements, permits morphologic classification of the pelvis, and observations of the fetal skeleton.

ALTON S. HANSEN, M.D.
Peoria, Ill.

Possible Significance of Arterial Visualization in the Diagnosis of Placenta Previa. A Preliminary Report. Leo J. Hartnett. Am. J. Obst. & Gynec. **55:** 940–952, June 1948.

A series of 68 aortograms, of women in the later stages of pregnancy, obtained with intent of outlining the maternal circulation over the placental site, is reported. Diodrast and sodium iodide were employed, the dosage being 18 c.c. of a 70 per cent solution or 10 c.c. of an 80 per cent solution. Sodium iodide provided the better visualization. The procedure was attempted only when the urinary function was within the limits of normal and non-sensitivity to the medium had been established by intradermal and intravenous tests.

Aortic puncture was done in the prone position under sodium pentothal anesthesia. The first roentgenogram was made as the injection was completed, the second within seven seconds. The average settings were 75 kv. and 200 ma. at 0.5 seconds, with a high-speed Bucky grid.

Periaortic retroperitoneal extravasation was the most important complication encountered. Thirteen such instances occurred and were attended by lumbar pain and mild temperature rise over a twenty-four-hour period. Accidental injection of specific arterial vessels produced no ill effects.

Care with the speed of injection is recommended. Sodium iodide injection required at least five seconds, more rapid administration producing marked intimal irritation and tetanic uterine contractions, with occasional evidence of fetal distress. No instance of premature labor was encountered. Introduction of diodrast was uneventful, and only rapid injection afforded satisfactory concentrations.

No subsequent traces of iodide were found in the placentas, nor could microscopic damage of the chorionic villi be demonstrated. All women delivered without mishap and all babies were living and unaffected.

The author offers the procedure as one which will positively locate the placenta. When possible, implantation sites were checked at delivery and were found to correspond uniformly with the roentgenograms. Two cases of placenta previa were encountered and aortic puncture was without ill effect. The author feels that further study is warranted before satisfactory comparison of the risks entailed as against those of "watchful expectancy" in the treatment of bleeding during pregnancy can be made.

Nine roentgenograms; 2 photographs.

G. D. DODD, M.D.
Jefferson Hospital, Philadelphia

THE GENITO-URINARY SYSTEM

Roentgen Considerations of Pyelonephritis in Small Kidneys. Eugene P. Pendergrass, Richard H. Chamberlain, and Frank P. Brooks. Am. J. Roentgenol. **59:** 651–661, May 1948.

The authors discuss the diagnostic problems relative to the unilateral small kidney, classifying the condition as (1) hypoplasia of the kidney and (2) acquired atrophy, the latter including (*a*) atrophic chronic pyelonephritis, (*b*) primary atrophy, and (*c*) pyonephrosis. They have observed approximately 60 cases. In addition to diminution in size, these frequently showed sharp demarcation of the renal contour from the surrounding soft-tissue densities. In many cases the mobility of the kidney was restricted, and clearance of intravenous contrast medium was often impaired.

The small kidney, with or without urographic evidence of pyelonephritis, was found on the first examination in every one of the patients studied. The condition was observed in both children and in adults. Histories of previous infection were not informative.

Many cases of pyelonephritis are observed in which the kidneys are not small. In bilateral pyelonephritis, only one kidney appeared to be small in practically every instance. Small kidneys, presumably

hypoplastic, were found in which there was no clinical evidence of disease. Yet if a patient is hypertensive, such a small kidney found on urographic study might lead one to suspect either pyelonephritis with contracted kidney or renal relationship to the hypertension. Similar observations obtain in the contracted kidney of pyelonephritis, and the authors were unable, with urography, to differentiate with certainty between hypoplasia and the small kidney with pyelonephritis.

Several case reports are included.

Twenty-two roentgenograms.

G. K. VOLLMAR, M.D.
The Henry Ford Hospital

Dyspepsia and Serous Cysts of the Kidney. Earl E. Ewert and Lloyd D. Flint. S. Clin. North America **28:** 785–792, June 1948.

In the presence of serous cysts of the kidney, abdominal pain and digestive tract disturbances often confuse the clinician until a urologic investigation is done. In some cases, serous cysts of the right kidney may simulate biliary tract disease. In contradistinction to congenital polycystic kidneys, these renal cysts occur at an age when there are arteriosclerotic changes associated with inflammatory fibrosis.

In the series of 54 cases reported here, the most common location of cysts was in the lower pole (28 cases). Abdominal pain or pressure is the predominant symptom, but is in no way characteristic and varies in location. When there is symptomatology related to the genito-urinary system, the cyst is always overshadowed by associated pathologic changes.

The diagnosis of serous cysts of the kidney is based on pyelography, either retrograde or excretory. The typical pyelogram shows a compression of the calices with an elongation of the calyx as if in an attempt to encircle the cyst in a "ball and claw arrangement." There may be no distortion or displacement present or there may be marked compression of the ureter, pelvis, or both, with hydronephrosis and even calcification. All the findings described can be simulated by a malignant tumor, and surgery is advised in every case to eliminate that possibility. Some extrarenal conditions that may confuse the diagnosis are retroperitoneal cysts, cysts of the mesentery, omentum, adrenal, pancreas, and spleen.

The treatment for serous cysts of the kidney is surgical excision through a lumbar exposure. The surgical technic is discussed and can be summarized as simple excision and cauterization. All the patients studied were relieved of their symptoms with the excision of the cyst, with the exception of two, one with an anxiety neurosis and the other an alcoholic with a hiatus hernia.

One case with symptoms and findings pointing toward the gastro-intestinal tract is reported.

Three roentgenograms; 3 tables.

JOE B. SCRUGGS, JR., M.D.
University of Arkansas

Role of the Sphincters in the Pelvis of the Ureter. Cecil J. A. Woodside. Urol. & Cutan. Rev. **52:** 320–322, June 1948.

The author became interested in the sphincteric control of the ureter after doing sympathectomies for hydronephrosis due to an achalasia of the pelviureteral sphincter. Pyelograms in these cases showed that in the early stages of this disease, the pelvis proper was considerably distended, but the major and minor calices were not. In long standing cases, or cases of more rapid development, the major calices might also be distended and their junctional zones widened, while the minor calices appeared normal. In later stages, these, too, became somewhat distended and blunted. In each stage, marked constriction was noted at the junctional zones, where the major calices join the pelvis, or where the minor calices arise from the major calices. The author surmised, therefore, that there must be some form of effective barrier preventing the increased pressure from the pelvis reaching the renal tubules, and came to the conclusion that sphincters must exist at the junctional zones.

Such sphincters have been described by others, but from a physiological point of view. They divide the pelvis into three chambers, the first being equal to the total number of minor calices, the second to the major calices, while the third is equivalent to the pelvis proper. Filling and emptying take place serially when a certain pressure is attained at each level so that the sphincters relax, contracting again when the next chamber fills up, to prevent a reflux. The author believes that these sphincters play the further roles of (1) protection against increasing pressure from below and (2) inhibition, when subject to neuromuscular imbalance, of obstruction of the pelvis or its adnexa.

Five roentgenograms

MAURICE D. SACHS, M.D.
Cleveland, Ohio

Congenital Megaloureter and Hydroureter. Pathogenesis and Classification. G. E. Irvin and John E. Kraus. Arch. Path. **45:** 752–765, June 1948.

The authors present 4 cases with autopsy findings and comment on the genesis, the classification, and the nomenclature of congenital ureteral enlargements. Three morphologic types of this condition are recognized: (1) megaloureter, representing congenital hyperplasia, which is manifested by thickened walls and by increased length with tortuosity, without evidence of organic obstruction—an anomaly having its analogue in other parts of the body; (2) a dilated ureter (hydroureter), the result of the presence of an organic obstacle obstructing the flow of urine, as seen in the obstructions acquired from any number of organic conditions; (3) an intermediate type representing a megaloureter which, because it has been unable to maintain a normal flow of urine, has become secondarily dilated through retention.

One roentgenogram; 5 photographs.

Typical Roentgen Picture of Very Large Ureteroceles. Ulf Rudhe. Acta radiol. **29:** 396–402, May 31, 1948.

The typical picture of ureterocele as given by most authors is applicable only to those of small or moderate size. It does not apply to those of very large dimensions. Three cases of the latter type are described. In these the ureterocele appeared, on urography—and in one case also on urethrocystography—as a large, rounded, distinct soft-tissue formation causing a corresponding defect in the bladder contrast. In male patients past middle age the picture might be confused with prostatic hypertrophy. Double pelves and ureters are a common associated finding. When reduplication occurs, the ureterocele usually involves the ureter from the superior pelvis. In the presence of the

very large ureterocele, one must look for impaired renal function on the affected side.

Eight roentgenograms: 1 drawing.

EUGENE KUTZ, M.D.
Baltimore (Md.) City Hospital

Cystography with Graduated Compression. Olle Olsson. Acta radiol. **29:** 429–434, May 31, 1948.

In cases of bladder neoplasm, cystography may be of more value than cystoscopy in determining the size, shape, extent of infiltration, and other pertinent data about the lesion. Cystography has, nevertheless, made little progress as compared with other roentgenographic procedures used in studies of the urinary tract.

The fact that the bladder holds a large amount of fluid makes for a thick layer of contrast medium when such is instilled for ordinary cystography. Attempts have been made to overcome this inconvenience by using various concentrations of radiopaque substances, by taking films in various projections, and by filling the bladder to various degrees. Combinations of positive and negative contrast media are also employed.

Since more information about lesions of the stomach can be obtained by actual palpation of the stomach and by the use of various degrees of compression, the author felt that palpation of the urinary bladder would also furnish additional information. He therefore devised what he terms a "distinctor" for this purpose. This is essentially a wooden paddle shaped like a urethral sound except that it is broader and flatter and has less curve at its distal end. This is inserted into the rectum and during fluoroscopy the bladder filled with the contrast medium is selectively compressed. Filling defects may then be studied with varying thicknesses of the layer of contrast substance. Several illustrations demonstrate the value of the procedure.

Twelve illustrations, including 8 roentgenograms.

S. H. MACHT, M.D.
Baltimore (Md.) City Hospital

On the Roentgen Aspect of Prostatic Cancer by Urethrocystography. Nils P. G. Edling. Acta radiol. **29:** 461–474, June 30, 1948.

The author has made a study of urethrocystograms in 68 cases of prostatic cancer compared with as many cases of prostatic hypertrophy. On the basis of this he concludes that an elongation of the prostatic urethra combined with a narrow and irregular lumen, abrupt kink of the luminal course, irregular bulgings into the base of the bladder, and displacement anteriorly or laterally of the entire prostatic urethra may constitute a characteristic cancer picture. The latter is the most significant finding. The absence of these signs, however, does not eliminate clinically suspicious cancer.

Fourteen roentgenograms.

ROBERT LARNER, M.D.
Baltimore (Md.) City Hospital

Urethrography: A Diagnostic Aid in Diseases of the Lower Urinary Tract. William E. Goodyear, Donald E. Beard, and H. Stephen Weens. South. M. J. **41:** 487–494, June 1948.

Urethrography is a valuable diagnostic aid in diseases of the lower urinary tract and is considered an adjunct to other methods of examination. With a simplified technic using iodized oil (20 to 30 c.c.) the authors have found a single exposure satisfactory for routine examinations. This is made with the patient in a forty-five degree oblique position, and the film centered on the symphysis pubis. Moderate traction is applied to the penis during the procedure. Normal respiration is continued during exposure, as it allows a normal tone of the external sphincter.

Urethrography has proved to be of great value in the study of urethral strictures, prostatic hypertrophy, prostatitis, and in postoperative cases. No characteristic picture is seen in carcinoma of the prostate.

The complications of urethrography with iodized oil are insignificant.

Fifteen roentgenograms; 1 drawing.

JOHN DECARLO, JR., M.D.
Jefferson Medical College

Roentgenologic Changes in the Urinary Bladder and the Distal Portion of the Ureters in Spermatocystitis. Gunnar Edsman. Acta radiol. **29:** 371–382, May 31, 1948.

Spermatocystitis is a seldom diagnosed entity which may complicate or be obscured by coincident disease of the lower urogenital tract. Since filling of the seminal vesicles with radiopaque contrast substances *via* the ejaculatory ducts or by vasopuncture is a most difficult and tedious procedure, an indirect approach is offered, based on the inflammatory effect on adjacent organs. The limited basal cystitis forms the anatomopathological basis for the roentgenologic changes in the fundus of the bladder, which may be seen in the urethrocystograms in cases of spermatocystitis.

In the oblique position, irregular indentations of the mucous membrane may be seen in the fundus of the bladder. Five such instances are well illustrated by case histories and radiographs. A brief review of the anatomy concerned is given plus three additional case reports with radiographs illustrating ureteral stenosis associated with spermatocystitis. [No mention is made of the reliability of the method in proving the presence of this entity in a series of cases, and one therefore assumes that those reported are selected merely to illustrate the author's point.]

It is suggested that consideration be given spermatocystitis in obscure cases of ureterectasis and hydronephrosis.

Thirteen roentgenograms; 1 drawing.

HARRY J. PERLBERG, JR., M.D.
Baltimore (Md.) City Hospital

THE BLOOD VESSELS

Cerebral Angiography. A Clinical Evaluation Based on 107 Cases. John R. Green and Roman Arana. Am. J. Roentgenol. **59:** 617–650, May 1948.

This article is an excellent detailed general review of the subject of cerebral angiography. There is considerable basic discussion of anatomical studies and details of the technic. The authors recommend percutaneous injection of the common carotid under general anesthesia. Diodrast is preferred for routine use.

The authors list the following indications for the procedure: (1) diseases of blood vessels, (2) cerebral neoplasms, (3) miscellaneous (when other diagnostic methods fail). They devote considerable space to the first two classifications, with case reports and supporting illustrations.

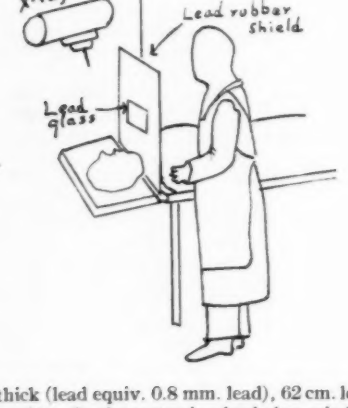
The report is based on 107 examinations.

Twenty-three illustrations, including 20 roentgenograms; 2 tables.

G. K. VOLLMAR, M.D.
The Henry Ford Hospital

A New Protector in Cerebral Angiography. Arne Engeset. Acta radiol. **29:** 503–508, June 30, 1948.

It has been shown that during one exposure in angiographic work the hands of the surgeon receive 0.2 to 0.3 r. In the author's x-ray department 300 to 400 angiographic examinations are performed annually. It therefore became necessary to devise a protective device to minimize the primary radiation received by the surgeon. This device consists of a sheet of lead rubber



3 mm. thick (lead equiv. 0.8 mm. lead), 62 cm. long and 60.6 cm. wide. In the center is a lead glass window and at the bottom of the sheet is an oval cut-out space. The protector is counterbalanced from the ceiling and may be lowered over the patient's neck during exposure. Since it is then between the x-ray tube and the surgeon, protection is afforded. This is proved by measurements made by a physicist.

Three photographs; 1 drawing; 1 table.

STANLEY H. MACHT, M.D.
Baltimore (Md.) City Hospital

Visualization of the Coronary Arteries. Preliminary Report. Gunnar Jönsson. Acta radiol. **29:** 536–540, June 30, 1948.

The author presents a preliminary report on roentgenographic visualization of the coronary arteries by the injection of an opaque medium into the aorta through a catheter threaded through the radial artery. In five cases studied by this technic filling of one or both coronary arteries occurred. Several illustrations show the sinus of Valsalva, the semilunar valves, the coronary arteries, and a patent ductus arteriosus. The technic is that used by Radner and others. (Acta. radiol. **29:** 178, 181, 1948. Absts. in Radiology **52:** 139, 1949).

STANLEY H. MACHT, M.D.
Baltimore (Md.) City Hospital

Peripheral Vascular Disease in the Lungs. Roentgenologic Manifestations. Robert P. Barden and David A. Cooper. J. A. M. A. **137:** 584–588, June 12, 1948.

The authors have classified conditions affecting the small vessels of the lung in three groups: those in which there is intrinsic disease of pulmonary vessels, those secondary to pulmonary parenchymal disease, and those resulting from toxic and hypersensitivity states.

Of the first group, arteriosclerosis and arteriolar sclerosis so regularly accompany long-standing pulmonary emphysema that they should be assumed as coexistent when there is roentgen evidence of the latter. Obliterative vascular disease should also be suspected in patients without emphysema but with pronounced symptoms of pulmonary insufficiency. An unusual cardiac silhouette is particularly suggestive, as cor pulmonale results from chronic pulmonary hypertension regardless of cause. Multiple emboli and thrombi obstructing minute pulmonary vessels may occur with leukemias, polycythemia vera, parasitic infestations, metastatic neoplasm, and, in fact, in any condition in which septic, organic, or inorganic particles circulate in the blood vessels. Roentgenograms show exaggeration of the pulmonary vascular pattern, with irregular "beading," which may progress to the picture of a symmetric bronchopneumonia.

Pulmonary parenchymal diseases produce obliteration of adjacent blood vessels resulting in delayed healing and eventually in impaired pulmonary function.

Hypersensitivity states cause changes in vessel walls, with increased permeability and resultant edema or hemorrhage. Chest films show fluffy shadows, usually extending from each hilus to occupy the inner two-thirds of each lung. Occasionally the densities are subpleural in location. Bronchial asthma, eczema, lupus erythematosus, acute rheumatic fever, and periarteritis nodosa are hypersensitive states producing such changes. Exactly similar changes are produced by toxins, whether chemical as in inhalation of irritating gases, bacterial as in epidemic influenza, or metabolic as in terminal stages of glomerulonephritis. It is particularly emphasized that roentgenographic changes produced by hypersensitivity states and toxins are entirely non-specific.

M. J. SHAPIRO, M.D.
University of Michigan

Arteriovenous Fistula of the Lung: Treated by Ligation of the Pulmonary Artery. George B. Packard and James J. Waring. Arch. Surg. **56:** 725–739, June 1948.

Cavernous hemangioma of the lung, usually congenital and multiple, represents a peripheral venous-arterial fistula, and the clinical symptoms result from the arteriovenous shunt. Cyanosis, clubbing of the fingers and toes, and polycythemia are always present. A bruit is sometimes heard. Dizziness, dyspnea, fatigue, faintness, and thickness of speech are common, and more than half the patients have external capillary hemangiomata on the body. The roentgenographic observations are practically diagnostic. There are one or more irregularly rounded, fairly discrete shadows anywhere in the lung field, usually not over 4 cm. in diameter, and with a vascular tail extending toward the lung root. At fluoroscopy, pulsation can usually be seen. Injection of 70 per cent diodrast into the median basilic vein leads to prompt filling of the aneurysm, establishing the diagnosis.

A case is reported here, in which the presence of multiple aneurysms in the right lung was treated by double ligation of the right pulmonary artery. This led to major improvement, although the right lung showed a little loss of aeration as a result of the operation. No bronchospirometric studies had been made, so that the

function of the lung postoperatively had not been determined. Clinical improvement of the patient was maintained over an observation period of three years.

Eight illustrations, including 5 roentgenograms.

LEWIS G. JACOBS, M.D.
Oakland, Calif.

Phlebography in the Localization of Incompetent Communicating Veins in Patients with Varicose Veins. Theodore B. Massell and Jerome Ettinger. Ann. Surg. **127:** 1217–1225, June 1948.

The authors call attention to the high incidence of recurrences of varicose veins in patients who have undergone high saphenous ligation. They recognize the fact that present methods of clinical examination for selection of patients for this procedure are not entirely adequate and have added phlebography as an aid to detecting communicating veins with incompetent valves which could be surgically excised with improvement of the operative results. They describe their phlebographic technic and the operative findings in 20 patients.

Operative findings in their cases are compared with clinical observations by tourniquet tests and also with phlebography. Phlebography has been found to be much more accurate than the clinical tests but there are some false positives and negatives by both methods. Incompetent veins can only be visualized by roentgenographic means when there is good filling of the deep veins with which they are connected. The authors have found it difficult to get a good injection of all three pairs of deep veins in the lower legs. The anterior tibials are the most difficult to visualize and at times the posterior tibial veins are not completely filled. Visualization of the peroneal veins is almost always excellent.

Five roentgenograms; 5 drawings; 2 tables.

DONALD R. BRYANT, M.D.
The Henry Ford Hospital

TECHNIC

Amplification of the Fluoroscopic Image by Means of a Thick Dense Clear Crystalline Detector Screen and a Scanning Roentgen-Ray Tube. Robert J. Moon. Am. J. Roentgenol. **59:** 886–888, June 1948.

The author describes his method of amplification of the fluoroscopic image "in essence" as follows: "A scanning roentgen-ray tube generates a scanning roentgen-ray beam which after passage through the patient falls upon a clear dense crystalline fluorescent screen. Here the roentgen rays produce visible or near-visible light quanta which in turn create a photoelectric current which is amplified and subsequently used to modulate the magnitude of an electron beam current in a kinescope. . . . Since the electron beam in the roentgen-ray tube and the electron beam in the kinescope are both driven by the same sweep circuits a roentgen shadow image will be reconstructed on the kinescope screen."

For a critical consideration of this procedure and of the method suggested by Coltman (Radiology **51:** 359, 1948) for accomplishing the same end, see the Editorial in Radiology, September 1948 (**51:** 414).

One drawing.

Characteristics of Commercial X-Ray Intensifying Screens and Films. III and IV. Willard W. Van Allen. Pub. Health Rep. **63:** 746–748, June 4, 1948; **64:** 430–432, April 1, 1949.

The author adds to the series of reports published periodically in Public Health Reports on the characteristics of commercial x-ray intensifying screens and films, with the purpose of keeping this information up-to-date. In this connection the reader is referred to "Characteristics of X-Ray Films and Screens" by Morgan (Radiology **49:** 90, 1947) and to a further paper, by Van Allen and Morgan, "Sensitometry of Roentgenographic Films and Screens," to appear in the June issue of RADIOLOGY.

Three tables in each paper.

Copying X-ray Films. David M. Gould, Willard W. Van Allen, and Charles M. Bailey. Pub. Health Rep. **63:** 763–765, June 4, 1948.

A method of copying films is described which makes use of the photofluorographic hood and automatic 70 mm. camera mounted vertically on a light box. The automatic timer is altered to accommodate the necessarily long exposures.

One photograph.

S. F. THOMAS, M.D.
Palo Alto, Calif.

RADIOTHERAPY

Treatment of Cancer of the Maxillary Antrum by Radium. Margaret C. Tod. Brit. J. Radiol. **21:** 270–275, June 1948.

Two hundred and twenty-two cases of carcinoma of the maxillary antrum were treated with radium alone. Of these 95 were early and 127 late. Of the patients in the early group, 36 per cent survived five years, and in the late 17 per cent.

The method of treatment was remarkably simple. A single radium source was inserted into the middle of the tumor, usually through a Caldwell-Luc approach, or sometimes by just pushing the tube through the destroyed bone, under intratracheal anesthesia. A dose of 8,000 to 10,000 r in seven to ten days, measured at a point 2 cm. from the center of the radium source, was used.

Tumors of the mixed salivary type are so radioresistant that they should not be treated by irradiation. Reticulo-endothelial tumors are so radiosensitive that they are better treated with external roentgen therapy.

Seven illustrations, including 4 roentgenograms.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Cancer of the Larynx. A Statistical Study. LeRoy A. Schall and John J. Ayash. Ann. Otol., Rhin. & Laryng. **57:** 377–386, June 1948.

This is a report of 418 cases of cancer of the larynx, of which 246 were treated by external irradiation, 158 by surgery alone or surgery with irradiation, and 14 by "radium with other treatment." The irradiation technic has varied over the fifteen-year period covered by this series (1930–45). Earlier cases usually received less than 5,000 r over a period of two or three months. For the past five or six years a total dose of at least 6,000

and more often 7,000 r has been given in four weeks, with additional treatment for extension of the disease and metastases.

Though one might expect a higher percentage of cures with the increased dosage, the results have been disappointing. The five-year cure rate for 1930–40 was 23 per cent, but of 147 patients treated from 1941 to 1945, 70 per cent were already dead at the time of the report. Three per cent had survived five years and 27 per cent for lesser periods.

The site of the lesion and the degree of extension of the disease have been found to be of more importance in the proper choice of treatment than the grading of the tumor. In general, however, the results of both surgery and irradiation are better in Grades 1 and 2 than in Grades 3 and 4. When the disease is intrinsic, particularly when it involves the vocal cords or the supraglottic structures, the chances of a cure by external irradiation are best. As the lesion extends beyond the larynx, the prognosis grows definitely worse. It is almost nil when the extension reaches the tongue, and 85 per cent of the authors' patients with node involvement had died.

The laryngeal cancer ideal for thyrotomy or laryngofissure is a localized lesion of the anterior third or the middle of a vocal cord, without involvement of the anterior commissure or extension to the vocal process, preferably of low grade, and without fixation of the cord. A review of failures with laryngofissure reveals that recurrences have been observed chiefly in those cases in which the cancer had reached the anterior commissure, had crossed to the other cord, or reached the vocal process. Extension of the growth to the anterior tip of the opposite cord is still amenable to laryngofissure by wider dissection. Any fixation or posterior extension to the arytenoid, even without fixation, contraindicates laryngofissure.

When external irradiation fails to control the disease, surgery can still be done, although the healing may be delayed. In this series laryngofissure was done in four cases and laryngectomy in eight after external irradiation failed to control the disease.

Summarizing their observations, the authors state: "Limited lesions of grades 3 and 4 are best treated by surgery followed by postoperative external irradiation....

"Early unfixed cordal lesions are 46 per cent radiocurable by concentrated external irradiation. With the extension of the disease to the subglottic space and with cord fixation, laryngectomy is the treatment of choice and not external irradiation. Patients with borderline cases, cases which some observers call extrinsic, can be successfully treated by surgery and irradiation.

"In a group of poorly selected cases, five-year cures were obtained by laryngofissure in 58 per cent. Total laryngectomy on a series of patients operated on between 1930 and 1940, and therefore followed over five years, resulted in a 64 per cent survival."

It is further concluded that, in the hopeless case of cancer of the larynx, external irradiation is not palliative and often hastens death. Regression of the lesion does not signify a cure; the patient must be kept under close observation for at least five years. The so-called trial period of irradiation is a fallacy. A full curative dose of external irradiation is necessary to determine radiosensitivity.

Ten tables.

STEPHEN N. TAGER, M.D.
Urbana, Ill.

Prognostic Significance of Early Diagnosis in Breast Cancer. A Study of the Early Symptoms and Their Duration Before the Patients Come Under Treatment. Sigvard Kaae. Acta radiol. **29:** 475–492, June 30, 1948.

The author presents an analysis of 500 consecutive cases of breast cancer and Paget's disease of the nipple, from the Radium Center in Copenhagen. All but 5 cases were in females. Forty-three patients had had radical operation elsewhere and were referred for postoperative roentgen therapy; the others had received no treatment except for biopsy or local tumor extirpation in some cases.

The first sign was a nodule in the breast in 74 per cent of the cases; painful sensations in the breast, axilla, or arm in 12 per cent of cases; retraction of the nipple in 4.2 per cent; discharge from the nipple in 2.7 per cent; axillary lymph node in 2.5 per cent, and ulceration in the breast in 1.7 per cent. One-third of the patients consulted a physician within a week of their observation of the first signs, one-half within a month, two-thirds within three months, and 77 per cent within six months.

The length of time from the first medical examination to the institution of adequate treatment was one week or less in 59 per cent of cases, one month or less in 78 per cent, three months or less in 86 per cent, six months or less in 91 per cent, and one year or less in 95 per cent.

To show the importance of early diagnosis and treatment, the author found that all the cases which came under treatment within two weeks were technically operable. The operability rate dropped to 71 per cent when the delay in treatment was one year.

Seven tables.

ROBERT LARNER, M.D.
Baltimore (Md.) City Hospital

Introduction to Symposium on Cancer of the Esophagus and Gastric Cardia. George T. Pack. Surgery **23:** 867–873, June 1948.

In this paper introducing a symposium on cancer of the esophagus and gastric cardia, Pack gives a brief review of the results of surgical and radiation therapy in these cases, with some of the reasons for the generally pessimistic attitude of the profession. The latter include late diagnosis, perforation, high grade of malignancy, poor general condition by the time the diagnosis is made, infrequent use of esophagoscopy, frequency of coexistent pulmonary or cardiac disease in the age group in which these tumors occur. Failure of radium therapy is attributed to the difficulty of obtaining adequate distribution of the dose and of reaching distant sites of extension, and to necrosis and sloughing of the infected tumor.

Roentgen therapy has been followed by good palliative results, and Nielsen is quoted to the effect that, at least to Scandinavian radiologists, "there is no doubt that the difficult task of trying to treat esophageal cancer both radically and symptomatically will to a very great extent continue to be the domain of radiotherapy." Nielsen's work with rotation roentgen therapy is described (see Absts. in Radiology **40:** 114, 1943; **47:** 100, 1946).

The other papers in the Symposium are chiefly of surgical interest. One, by Sherman, on diagnosis is abstracted elsewhere in this issue of Radiology (p. 756).

Three photographs; 1 drawing.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Dosage Measurements for Various Methods of Intrauterine Radium Applications in Cancer of the Endometrium. James F. Nolan and William Natoli. Am. J. Roentgenol. **59:** 786–795, June 1948.

By means of a phantom and suitable film the authors plotted isodose curves for radiation therapy of endometrial cancer by six different technics: The technics were: (1) short tandem; (2) long tandem; (3) "Y" applicator (tandem same as in (1) plus 2 large capsules in the cornea); (4) long tandem, as in (2) plus 2 small capsules in the cornua; (5) 7 large capsules; (6) 13 small capsules.

The film was placed between the layers of the phantom, and the density of the blackness was measured with a densitometer to determine the various dosages.

Isodose curves are presented for each technic, showing a definite improvement in the uniformity of distribution as the number of sources was increased, the 13 small capsules giving the most uniform field. In this experiment the cavity remained constant in size and shape.

More uniform radiation will allow higher milligram-hour values because of the elimination of hot spots, and should therefore result in better tumor control.

Nine figures; 2 tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Sarcoma of the Uterus. Report of Eighteen Cases. Thomas Perry, Jr. New England J. Med. **238:** 793–799, June 3, 1948.

This is a report of 18 cases of uterine sarcoma from the Rhode Island Hospital occurring in the last eighteen years. This type of growth is uncommon. Of the 18 cases, 7 were leiomyosarcoma, 4 mixed mesodermal sarcoma, 3 carcinosarcoma, 2 giant-cell sarcoma, 1 stromal-cell sarcoma, and 1 botryoid sarcoma, this last in an infant of five and a half months. Panhysterectomy with bilateral salpingo-oophorectomy is considered to be the treatment of choice. Irradiation seems to have no effect on the tumors.

Several case reports are presented. One patient had been given 1,000 mg. hr. of radium to the uterus in September 1924, for menopausal bleeding. In December 1934, a complete hysterectomy was done, showing a mixed mesodermal tumor of the uterus. Another patient had received 1,400 mg. hr. of radium for menopausal bleeding in January 1937. In May 1943, the uterus was found enlarged and a hysterectomy showed carcinosarcoma. This patient had a recurrence and x-ray therapy was without influence on the growth.

One roentgenogram; 9 photomicrographs; 2 tables.
JOHN B. MCANENY, M.D.
Johnstown, Penna.

Granulosa-Cell Tumor of the Ovary, with Special Reference to Radiosensitivity. Robert D. Moreton and Eugene T. Leddy. Am. J. Roentgenol. **59:** 717–726, May 1948.

This article is concerned chiefly with the radiosensitivity of granulosa-cell tumors. It includes a considerable review of the literature.

Of 50 cases of granulosa-cell tumor seen at the Mayo Clinic, 11 received radiation therapy. Six patients were alive at the time of the report, 1 for one year and the remaining 5 more than nine years. No comparison is made between the survival rates of this group and the 39 cases which did not receive radiation therapy.

The authors state: "From a review of the literature it is difficult to draw conclusions about the radiosensitiveness of granulosa-cell tumors." They do not clear up the difficulty.

One table; isodose curves. G. K. VOLLMAR, M.D.
The Henry Ford Hospital

Treatment of Carcinoma of the Prostate with Radium. Raymond Darget. Urol. & Cutan. Rev. **52:** 352–357, June 1948.

High hopes were entertained for the therapeutic effectiveness of hormones and orchiectomy for carcinoma of the prostate. These have not, however, been fully realized and there has been some return to the older methods of prostatectomy and radium application. These methods, it is felt, can be used as a supplement to hormonal treatment and orchiectomy.

The author uses radium, which may be applied through a transvesical approach, through a perineal incision, or with a radium holder catheter.

Forty-seven cases were treated, in 21 of which it would have been impossible to do any form of prostatectomy. In 29 cases perineal implantation was done; in 3, transvesical and perineal implantation; in 3, transvesical implantation alone; in 11, a radium holder catheter was used, and in 1 treatment was by perineal implantation and radium holder catheter. Eighteen patients were alive at the time of the report; one of these had survived five years. Radium was not used in suspected or proved cases of metastasis.

Eleven illustrations, including 6 roentgenograms.
MAURICE D. SACHS, M.D.
Cleveland, Ohio

Intensive Radium Therapy with Beta Rays. Paul de Plaen. J. de radiol. et d'électrol. **29:** 264–267, 1948. (In French.)

This paper is of interest to American radiologists on two counts: (1) It reviews the early experimental work on the local action of beta rays. (2) The authors have used the 50 mg., 0.3-mm. monel-wall Crowe nasopharyngeal applicator for the treatment of cancers of the skin, lip, urethra, vulva, etc. The paper describes the physical characteristics of the applicator and the tissue doses thereby obtained, which should serve to emphasize to American radiologists and otolaryngologists the hazards both to themselves and patients, inherent in careless use of so potent a source of caustic radiation.

Four photographs; 5 tables.
SIMEON T. CANTRIL, M.D.
Seattle, Wash.

RADIOACTIVE ISOTOPES

Spontaneous and Experimentally Induced Uptake of Radioactive Iodine in Metastases from Thyroid Carcinoma: A Preliminary Report. S. M. Seidlin, E. Oshry, and A. A. Yalow. J. Clin. Endocrinol. **8:** 423–432, June 1948.

Fourteen unselected cases of metastatic thyroid carcinoma were studied with orally administered radioactive iodine (I^{131}) at the Montefiore Hospital, New York, up to June 1947. Tracer doses ranged from 500 to 2,000 microcuries. Urine was collected for at least the first forty-eight hours and the radioactive iodine content estimated. Forty-eight hours after the dose was administered, *in vivo* readings were taken with a Geiger-Müller counter to determine the degree of

localization of the isotope in the thyroid gland and the metastases.

Five of the 14 cases showed uptake in at least one metastatic lesion the first time radioiodine was administered. Subsequently, radioautographs were made from tissue from 6 of the 14 patients. In all of these, the autographs showed definite concentration of radioactive iodine in the metastatic tissue; in one, measurements had not indicated uptake, showing that the radioautographic technic, when feasible, is more sensitive than external measurements. In all 5 "positive" cases a complete or nearly complete thyroidectomy, or a subtotal thyroidectomy, had previously been done, followed by x-ray treatment. However, not all patients who had had partial thyroidectomy and irradiation showed radioiodine uptake by metastases.

The radioiodine uptake by the metastatic carcinoma was found to be more closely correlated to the degree of preceding thyroidectomy than to the histologic structure or "type" of the tissue.

It is concluded that, in cases in which initial studies with radioiodine do not show concentration in the metastases, such concentration may be induced by either thyroidectomy (surgical, radiation, or chemical) or injections of thyrotropic hormone.

Eleven illustrations.

RADIATION INJURIES

Cancer of the Corpus Uteri Following Radiation Therapy for Benign Uterine Lesions. Frank R. Smith and Lemuel Bowden. Am. J. Roentgenol. **59:** 796–804, June 1948.

An attempt was made to determine a possible relationship between the cancer of the uterus which developed in 8 patients and the radiation therapy they had previously received for various benign lesions. These 8 cases were seen during a twenty-year period, when 946 patients with cancer of the corpus uteri were admitted. Thirty-nine had had previous radiation therapy (exclusive of those who received irradiation for the cancer itself and were referred merely for continuation of treatment), but only 8 met the following criteria: (1) negative endometrial biopsy at the time of the irradiation for a benign lesion; (2) an interval of ten years or more between the initial irradiation and the onset of symptoms of cancer.

Two factors prevented a definite conclusion from being reached: (1) the prevalence of cancer of the corpus uteri in the general population is not known; (2) 100 per cent follow-up was not obtained, so that perhaps more than 8 cases occurred.

Four tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Lesions of the Urinary Tract Following Radiotherapy for Carcinoma of the Cervix Uteri. T. J. D. Lane. Brit. J. Urol. **20:** 67–71, June 1948.

The literature on injuries of the urinary tract following irradiation for the treatment of carcinoma of the cervix is reviewed, and 2 cases with vesical lesions are presented. In these cases excellent hemostatic effects were obtained with solid silver nitrate, in the form of a small bead on the end of a thin wooden rod, passed through a Braasch direct cystoscope.

Reconstruction Following Irradiation Injuries. Paul W. Greeley. Arch. Surg. **56:** 741–748, June 1948.

The author discusses generally the well known changes following excessive irradiation as seen in the superficial tissues. He states, "In spite of enthusiastic reports given by the advocates of local applications of radon paste or the aloe vera leaf, I have apparently seen only those patients that did not respond to such simple management. Since the pathologic reaction is progressive and irreversible, I feel that a permanent cure can be anticipated only when all of the damaged tissue has been excised back to an area of good blood supply. If this excision is not wide enough, further reconstructive operations will fail, and later degeneration may occur around or below the site of the original excision." After a radical excision, the problem of closure is solved occasionally by undermining and direct suture; more often by some type of skin-grafting operation.

Sixteen illustrations. LEWIS G. JACOBS, M.D.
Oakland, Calif.

Roentgen-Ray Calibration of Photographic Film Exposure Meter. L. J. Deal, J. H. Roberson, and F. H. Day. Am. J. Roentgenol. **59:** 731–736, May 1948.

This is a report of the use and calibration of a 2-film packet for determination of stray radiation. The emulsion of one film is sensitive to high-voltage (gamma) radiation, the other is relatively insensitive. In addition, one-half of the packet is covered by 1 mm. of cadmium, the other half by only the wrapper.

Numerous calibration curves are presented showing film densities for various voltages for the sensitive and insensitive emulsions and for the shielded and unshielded portions. Little difference was noted above potentials of 400 kv. Below this figure, the densities varied considerably under the different conditions. At the lower voltages considerable care must be exercised in ascertaining the portion of the potential region to which the film was exposed if this type of reading alone is used to determine exposure.

Five charts; 1 table. G. K. VOLLMAR, M.D.
The Henry Ford Hospital

Human Pathologic Anatomy of Ionizing Radiation Effects of the Atomic Bomb Explosions. Elbert DeCoursey. Mil. Surgeon **102:** 427–432, June 1948.

The author discusses the necropsy findings from about 260 Japanese dying as a result of irradiation at Nagasaki and Hiroshima. The material represents the work of many investigators, both American and Japanese.

Mainly the lymphoid and hematopoietic tissues, skin, genital organs and gastro-intestinal tract were affected. There was atrophy of lymphoid elements in lymph nodes, tonsils, spleen, and gastro-intestinal tract. Early there was atrophy of the bone marrow, which either continued or was followed by focal or diffuse hyperplasia with maturation arrest. Necrotizing inflammation of the oropharynx was prominent but limited to the third to sixth week. The scalp showed the surest external gross sign of ionization—alopecia. This with hemorrhagic lesions appeared about the same time as the throat lesions.

The testes showed prominent microscopic changes, almost all the sex cells being destroyed. The ovaries showed very little more than scarcity of proliferating follicles. The intestinal mucosa, mainly of the distal colon, was the site of changes which varied from ulcerated hemorrhagic foci to focal or widespread necrosis and ulceration with formation of diphtheritic membranes.

EXPERIMENTAL STUDIES

The Effect of Beta Rays on Cells Cultivated in Vitro. Ilse Lasnitzki. Brit. J. Radiol. **21:** 265–269, June 1948.

Avian fibroblasts were irradiated with beta rays at 244, 200 and 74 r/min., with a total dose of 1,000 r. Following irradiation there was a sharp fall in mitosis and the rapid development of abnormal mitotic figures and degenerating cells. The effects were qualitatively similar to those seen with x-rays and gamma rays, but the latent period was shorter and recovery more prompt.

Three graphs; 3 tables.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Effect of Low Dosage Roentgen Radiation on the Gonadotropic Function of the Hypophysis of the Mature and Immature Female Albino Rat. John H. Freed, Edmond J. Farris, Douglas P. Murphy, and Eugene P. Pendergrass. J. Clin. Endocrinol. **8:** 461–481, June 1948.

In view of the wide interest and frequent use of low-dosage roentgen irradiation in the treatment of functional endocrine dyscrasias, and the many controversial theories concerning its effect on glandular function, the authors thought it important to study the action of radiation on the normal pituitary of the experimental animal as manifested in its sexual system.

Five sexually mature female Wistar albino rats were given single doses of roentgen radiation to the pituitary, varying from 100 to 200 r, at 7:30 A.M. on the third day of their estrus cycles and none appeared to be affected by treatment.

Fifty-seven sexually mature female Wistar albino rats were given single or multiple doses of roentgen radiation to the pituitary varying from 5 to 300 r, at 7:30 A.M. on the second day of their estrus cycles. Twenty-eight additional rats were used as controls. Physiological signs of heat, ear quivering, and copulation response were observed in 28 of the 57 rats from one to two hours following treatment. These signs of heat lasted for six to eight hours. Fifteen of these 28 rats accepted the male; 4 pregnancies and one pseudopregnancy resulted. No change was noted in the running activity or periodicity of the estrus cycle of the treated rats. Gross anatomical studies and weight determinations were made of the pituitaries, ovaries and uteri of 6 of the treated rats who showed an ear quivering-copulation response, as well as the 7 controls. The pituitary weights of the treated rats appeared to be significantly greater than those of the controls. The ovarian weights were similar in the two groups. The uterine weights of the treated rats were slightly greater than those of the controls, but this increase was not nearly so definite as that noted in rats during normal estrus.

Sixteen immature female Wistar albino rats were given either a single or five successive daily roentgen treatments to the pituitary, with doses varying from 5 to 100 r per treatment. Six additional rats were used as controls. Eight of the immature treated rats were followed until vaginal opening occurred at ages ranging from fifty-three to sixty-five days. This is within the normal limits of age for the onset of sexual maturity.

Eight additional immature treated animals and 4 controls were sacrificed twelve days after irradiation of the pituitary, and pituitary, ovarian, and uterine weight determinations were made. Grossly the appearance and weight of the organs from the treated immature rats were in no way different from their controls.

As a result of these studies, the following conclusions were reached: (1) Low-dosage pituitary irradiation can produce a transient effect on the normal pituitary function of the rat. Though the immediate physiological effect is in the nature of a stimulus, such an effect is only transient and not prolonged. (2) Irradiation of the pituitary in small doses has no effect on the normal development of the sexual system of immature twenty-eight-day-old female rats. (3) There is no evidence that x-rays can stimulate living cells, if by stimulation is meant a continued acceleration of their normal growth or function. (4) Irradiation of the pituitary in small doses has no evident harmful effect in the experimental rat.

Two charts; 6 tables.

Absorption and Metabolism of Lipiodol After Oral Administration. Method for the Study of Fat Absorption and Fat Metabolism in Man. J. Groen. Am. J. Med. **4:** 814–826, June 1948.

The author studied the absorption of lipiodol by means of x-rays and determined the excretion of the iodine in urine and feces, as a test of fat absorption in man. At 7:30 A.M. the patient, having been tested for hypersensitivity to iodine, received a breakfast of two biscuits and 300 c.c. of tea. At the same time a mixture was given of 10 c.c. Lipiodol Lafay and 10 c.c. olive oil. This quantity contained 4.2 gm. of iodine (according to the manufacturers, it should contain 5.4 gm. of iodine). Between 7:30 and 12 no food was taken and no drugs were administered. It was found that a satisfactory picture of the course of absorption could be obtained by taking films at two, three and one-half, five, eight, and ten hours after administration of the contrast medium. When fat absorption is impaired, a considerable part of the contrast material remains visible in the films; it escapes absorption in the small intestine and may produce a contrast picture of the colon. Urine and feces were collected for twelve days and the iodine content was determined.

Normal absorption of lipiodol was found in achlorhydria, duodenal ulcer, uncomplicated cholelithiasis, peritoneal tuberculosis, obesity, and anorexia nervosa.

Diminished fat absorption was demonstrated in sprue, obstructive jaundice, intestinal tuberculosis, severe ulcerative colitis, gastrojejunocolic fistula, pan-

creatic insufficiency, in some cases of pernicious anemia and sometimes after stomach operation. The impaired absorption in non-tropical sprue improved but did not become completely normal after treatment with diet and liver extract.

The disadvantages of the method are its cost and the fact that it cannot be carried out in patients who are hypersensitive to iodine or who are severely ill.

The "fat relief picture" was not compared with that obtained with a barium meal. Roentgenograms are reproduced.

Effect of X-Rays on the Lymphatic Nodule, with Reference to the Dose and Relative Sensitivities of Different Species. P. P. H. De Bruyn. Anat. Rec. **101**: 373–405, July 1948.

Experimental studies carried out by the author show that the extent of histologic damage found in the lymph nodes of animals exposed to x-rays is correlated with the dosage given. This relationship is seen in the amount of nuclear debris resulting from the destruction of lymphocytes, but is more strikingly evident in the destructive and regenerative changes in the nodules of the lymph nodes and intestinal lymphatic tissue.

Rabbits, rats, and guinea-pigs were irradiated with x-rays, 200 kv.p., filtered with 0.5 mm. of copper and 1.0 mm. of aluminum. The dose rate varied from 11 r/min. to 16 r/min. The animals were killed in pairs at varying intervals after irradiation. The mesenteric lymph nodes, patches of Peyer, and, in the rabbit the appendix as well, were fixed in Zenker-formol, embedded in celloidin and stained with hematoxylin-eosin-azure II. The measure of lethal sensitivity to x-rays employed was the dose which kills 50 per cent of the animals within thirty days (L.D. 50/30 days).

Under the conditions of the experiments, the following changes occurred in the lymphatic nodules: (*a*) In rabbits, doses of 800 r and 600 r completely destroyed the great majority of the nodules, resulting in a "nodule-free" period until about three weeks after treatment, at which time new nodules began to form. After 400 r, the majority of the nodules were only partially destroyed. These regenerated rapidly and at five days were normal in appearance. A dose of 100 r did not produce a marked change in the majority of the nodules. Judging from the amount of debris, 50 r is the lowest dose which produces histologically detectable changes. (*b*) In rats, doses of 600 r and 400 r produced changes identical to those observed in rabbits at these doses. (*c*) In guinea-pigs, a dose of 175 r produced changes comparable to those in rabbits and rats after 400 r or less.

Since the L.D. 50/30 days of x-rays for rabbit, rat, and guinea-pig are 800 r, 600 r, and 175 r, respectively, it appears that the intensity of damage to the lymph node in these species is related to absolute dosage and is independent of the L.D. 50/30 days of these species.

Evidence obtained from the regeneration of the lymphatic nodules after their elimination by irradiation indicates that one of the phases in the cyclic changes in the nodules is of a proliferative character, notwithstanding the presence of signs of cell death.

Twenty-five photomicrographs.

Distribution of Radioactivity in the Mouse Following Administration of Dibenzanthracene Labeled in the 9 and 10 Positions with Carbon 14. Charles Heidelberger and Hardin B. Jones. Cancer **1**: 252–260, July 1948.

Dibenzanthracene, labeled in the 9 and 10 positions with C_{14}, was administered to mice intravenously and by stomach tube as an aqueous colloid, and intraperitoneally, subcutaneously, and by stomach tube in tricaprylin solution. The distribution of radioactivity in the mice was then determined at various time intervals after administration of the carcinogen.

It was found that the radioactive substances are rapidly eliminated, largely through the feces, and ordinarily very little material is absorbed. The distribution and rate of elimination depend upon the mode of administration.

There is an appreciable quantity of radioactivity in tumors produced several months after a single subcutaneous injection of dibenzanthracene.

There appear to be no detectable effects from the irradiation of the labeled carcinogen.

Seven tables; 3 charts.